

OVERSIGHT HEARING ON PFIESTERIA AND ITS IMPACT ON OUR FISHERY RESOURCES

OVERSIGHT HEARING BEFORE THE SUBCOMMITTEE ON FISHERIES CONSERVATION, WILDLIFE AND OCEANS OF THE COMMITTEE ON RESOURCES HOUSE OF REPRESENTATIVES

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OVERSIGHT HEARING ON PFIESTERIA AND ITS IMPACT ON OUR FISHERY RESOURCES

THURSDAY, OCTOBER 9, 1997

HOUSE OF REPRESENTATIVES, SUBCOMMITTEE ON FISHERIES CONSERVATION, WILDLIFE AND OCEANS, COMMITTEE ON RESOURCES, *Washington, DC*.

The Subcommittee met, pursuant to notice, at 10:08 a.m., in Room 1334, Longworth House Office Building, Hon. Jim Saxton [chairman of the Subcommittee] presiding.

Members present: Representatives Saxton, Gilchrest, and Jones. Also present: Representatives Clayton and Castle.

Mr. SAXTON. [presiding] Good morning. The Subcommittee on Fisheries Conservation, Wildlife and Oceans will come to order.

The purpose of this oversight hearing is to discuss the status of the Federal research incentives into Pfiesteria and the need for further investigation. The Subcommittee will also focus on scope of the harmful algal blooms and marine toxins that have been identified in other regions.

In particular, today's witnesses have been requested to address the scope of these harmful alga blooms, what ocean and estuarine conditions are necessary for the proliferation of these organisms, what ocean conditions are required for the organisms to enter the toxic phase, the ability of scientists to detect or predict outbreaks of these organisms, and whether a sufficient amount of research is being conducted to formulate solutions to these problems.

In addition, the Subcommittee will focus on the current coordination among Federal agencies and with State agencies in plans for future joint efforts, especially among researchers. Federal resources are already being targeted to address the Pfiesteria outbreak, and I look forward to hearing from our distinguished witnesses on how Federal funding can be effectively used to deal with these marine organisms.

The Ranking Member isn't here at the moment, although I am sure he will be shortly, and I know he is interested in this issue. Let me turn at this point to the gentleman from the eastern shore of Maryland, Mr. Gilchrest.

STATEMENT OF HON. WAYNE T. GILCHREST, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF MARYLAND

Mr. GILCHREST. Thank you, Mr. Chairman. I appreciate the fact that you're holding this hearing, and I also welcome all of the witnesses. We look forward to your testimony.

This is a phenomenon that is serious in that it has caused physical harm to humans, it's my understanding. It's also serious from

an economic perspective, but I would also comment that I think it is fascinating that this phenomenon has drawn such national attention, so that many more people other than the scientists in a lab will have some understanding of the nature of the mechanics of natural processes, and how they work in their natural habitat, and then how they work in their natural habitat impacted by human activity. And it's my understanding as a nonscientist that the potential impacts and the potential changes in natural organisms is, from a molecular structure, very difficult to predict, and probably there's an infinite number of possibilities.

So as we deal with this as nonscientists, we hope that you will help us draw a clearer picture of what we as people can do to try to resolve these issues, reduce human activity that perhaps has caused these, and head down the right direction. So we appreciate the fact that we know all of you are very busy, and we appreciate that you have come in here to address us today.

Thank you, Mr. Chairman.

Mr. SAXTON. Thank you. I thank the Ranking Member.

Let me just ask unanimous consent at this point that two Members who are here this morning who are not members of this panel—let me ask unanimous consent that Mr. Castle and Ms. Clayton be invited and permitted to join us on the panel.

Mr. Jones, would you like to make your opening comments?

**STATEMENT OF HON. WALTER B. JONES, A REPRESENTATIVE
IN CONGRESS FROM THE STATE OF NORTH CAROLINA**

Mr. JONES. Yes, thank you, Mr. Chairman. I'd join and associate myself with the statement made by the gentleman from Maryland, Mr. Gilchrest, that I very much appreciate you and the staff allowing this hearing to take place today, because it is an extremely serious problem in my district, as well as the district of Mrs. Clayton, because we share many of the same counties.

And it's gotten to a point that the people of eastern North Carolina that live along the waterways are very frustrated because we have seen this problem become worse each month and each year, to the point that it has become extremely detrimental to our packing houses that pack crabmeat, that sell to the North. Many of our industries, commercial fishing industries, are beginning to feel the economic problems that come when your sales drop. And, in addition, tourism in eastern North Carolina has been adversely affected by this *Pfiesteria* problem that has been growing in our region of the State.

So I really very much appreciate the opportunity to hear from the scientific community, as well as those from the State of North Carolina, as well as a gentleman that will speak with the second panel, Mr. Chairman, that has been so concerned about the Neuse River, which is in my district, that he has taken this cause on himself. I'm delighted that Rick Dove is here.

And so, with that, Mr. Chairman, I look forward—like the gentleman from Maryland, I have a lot to learn. I want to see what the Congress can do to work with the States to see if we can find a solution to the problem. So, again, I thank the witnesses for being here today, the panel, and we look forward to learning from you. And thank you very much.

Mr. SAXTON. I thank the gentleman from North Carolina for his comments.

Ms. Clayton, do you have a statement that you'd like to make?

**STATEMENT OF HON. EVA M. CLAYTON, A REPRESENTATIVE
IN CONGRESS FROM THE STATE OF NORTH CAROLINA**

Ms. CLAYTON. Yes, I do, and I ask unanimous consent to put my full statement into the record.

Mr. SAXTON. Without objection.

[The prepared statement of Ms. Clayton follows:]

STATEMENT OF HON. EVA M. CLAYTON, A REPRESENTATIVE IN CONGRESS FROM THE
STATE OF NORTH CAROLINA

Good morning. I would like to thank Chairman Saxton and Ranking Member Abercrombie for permitting me to participate. *Pfiesteria* is of great concern to North Carolina as the State has over 2.3 million acres of estuary—more than any other Atlantic Coast State. Estuaries play a critical role in the life cycle of marine fisheries as many commercial species feed, spawn and nurture their young there.

Pfiesteria has plagued North Carolina for many years, and experts now think that this organism was first observed in our waters almost twenty years ago in 1978.

While the Old North State has made multiple efforts to address this pestilence, through estuary studies, nondischarge rules, phosphate bans, rapid response teams, nitrogen load reductions, nutrient limit reductions, source wetland restoration programs and a two-year moratorium on new or expanding swine farms; *Pfiesteria* is an enigma for us all as it has been found in many Atlantic waters, from the Chesapeake Bay south to Florida and west to Texas.

Fishing is an industry of great importance to North Carolina, with 7,000 licensed fishermen and over a billion dollars in revenue yearly. In 1995 alone, commercial fishermen landed over 177 million pounds of fish, with a value of over \$112 million dollars.

In the area I represent, while the amounts are not as high as those in the district of my colleague from North Carolina, Walter Jones, who serves on this Subcommittee—the amount of fish landed in the seven coastal counties of North Carolina in the First Congressional District (Beaufort, Bertie, Chowan, Craven, New Hanover, Pamlico and Pender) was over 21 million pounds with a value over \$10 million dollars—11 percent of the entire state total.

Thus, the impact of *Pfiesteria* upon the fishing industry, in North Carolina and other coastal states—is significant as many of the affected counties derive most of their income from tourism and fishing, and most are severely economically disadvantaged to begin with.

It is imperative that we work together constructively and effectively, Federal, state and local governments and agencies, academic researchers, and concerned citizens—to attack and find rapid and workable solutions to this predicament.

I am pleased to note that two North Carolinians will be testifying today, the Honorable Wayne McDevitt, the Secretary of the North Carolina Department of Environment and Natural Resources and Dr. JoAnn Burkholder, who we proudly claim in North Carolina, from North Carolina State University.

Through her diligent research, we now know a great deal about the organism itself and its life cycle. All of us owe her a debt of gratitude for her tireless work, which put her at great physical risk for illness.

Now, it is time to fund additional work for Dr. Burkholder, and other scientists and researchers like her, in order to answer the remaining questions regarding the effects of *Pfiesteria* on humans, animals and watersheds.

The waters of North Carolina have certainly felt the effects of *Pfiesteria* outbreaks, especially in the Neuse River, the Tar River, the Pamlico River as well as the entire Albemarle-Pamlico Estuary, parts of which are in my Congressional District. There have been more than a million fish killed in our State and many reports of human health problems.

Given the adverse impact of such significant fish kills upon my District, North Carolina and the Mid-Atlantic, we need to seek solutions through aggressive research.

Mr. Chairman, we face a very serious threat that must be addressed immediately. We should not rush to judgement, however. Scientific inquiries are ongoing, but we should not waste time. Further research and testing should be undertaken at once.

It is my hope that funding for critically-needed research and testing will come as a result of today's hearings. Only through funding will come opportunities for solutions.

All North Carolinians that live, work and recreate in the affected waters, share that hope. Their lives and livelihoods depend upon it.

I was able to insert language into the House Agriculture Forestry, Resource Conservation and Research Subcommittee version of H.R. 2154, the Agricultural Research, Extension and Education Reauthorization Act of 1997, to authorize the use of research and extension grants to study the impact of *Pfiesteria* and other microorganisms that pose threats to human and animal health upon aquatic food webs.

Thanks again to Chairman Saxton and Ranking Member Abercrombie for allowing me to participate.

Ms. CLAYTON. And I want to express appreciation to you, Chairman Saxton, for affording me the courtesy to appear and to welcome your convening this meeting and how important it is for people in my district. I joined with Congressman Jones, and he has more than I, but it's certainly a substantial number of our counties, at least five of my counties, and about eight of his counties are engaged in this. Fisheries is an important industry in our area, and therefore, anything that affects its economic health is a serious implication to the opportunity of economic survival in that area.

It has grown in our area, but equally important to this whole problem is the potential for human health, and we do not want to diminish what that means. We don't want to be quick to judgment, but we do want to say that we must act, and we must act in a careful, but cautious way, but not so cautious that we are afraid to pursue.

I have been involved in trying to get our agricultural community involved, and *Pfiesteria*, for the first time, will now be a part of its research agenda that we got introduced into the legislation.

So, Mr. Chairman, I welcome what Members will be saying, individuals will be saying to the members of this Committee, and I want to welcome two of our North Carolinians who are here, who will make presentation, testimony, later.

Thank you.

Mr. SAXTON. Thank you very much.

Mr. Castle, do you have some comments?

STATEMENT OF HON. MICHAEL N. CASTLE, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF DELAWARE

Mr. CASTLE. Thank you, Mr. Chairman. Thank you for a couple of things. One, for my return to this room. I was on the Merchant Marine and Fisheries Committee before they abolished it, and this is a pleasant room to come back to. Maybe we should have kept it going, everything considered.

And I would like to thank you very much personally for listening to some of us who wanted this hearing in responding dramatically quickly, for Congress at least. We are very appreciative of that. I'd also like to thank Mr. Gilcrest, who I think has been a strong leader on this subject for some time.

I first came into contact, not directly but hearing about it, with—thank God, from what I've heard [Laughter]—with *Pfiesteria* in 1987, when I was the governor of Delaware. We had a massive fish kill in the Indian River Bay, just off the Atlantic Ocean, and it actually turned the waters mahogany brown. It hit every species of

fish in that particular waterway, and eventually—and it was sort of after the fact—it was linked to Pfiesteria.

This summer, again, we had tainted fish appearing off of Cape Henlopen and the Indian River and in the inland bays, and for people in Washington, that's in the Rehobeth area. That's what they identify with here in Washington; they all go there. And these are major fishing and recreational areas for Delawareans. It's not absolutely certain what that was, but it was a concern.

This, obviously, is not just a problem in Delaware. It's a problem in North Carolina; it's a problem in Maryland; it's a problem as far north as potentially New Jersey/New York and on down the coast. And I thought from the very beginning, when I started hearing about this this year, that we needed a national focus on this. We need a national coordinated effort by a lot of those various groups and agencies who are before us here today, by State and Federal agencies with vital input from researchers to work with the public to determine what the problems are and how to correct them. This is new to a lot of people.

And I believe that Congress has really stepped forward and played a major role in the Pfiesteria discussion, and I am pleased with this hearing, which I think continues that. I think that some of the responses have been positive in terms of action, too. We've appropriated \$11 million in funding to various Federal agencies, many of which we're going to hear from today, to study the causes, effects, and solutions, and effects on human beings' health, I might add, to the Pfiesteria phenomenon. And, indeed, this is the second congressional hearing which we have had on this subject.

This is a serious problem. We've heard about tourism here today. We all know that the sale of fish is down in certain areas, maybe even broader than certain areas in the United States of America. I have heard firsthand from Dr. Burkholder, who's going to testify today, just last week when she was kind enough to spend a good deal of time in Delaware, about the effects and impact on a research assistant of hers. There potentially is a human health problem here. We really don't know what the extent of all of this is, and most of us in Congress are not scientists—there are a few scientists in Congress; I'm not one of them, but they're there. And we really need to learn as much as we possibly can, so that we can coordinate the regional and national effort to try to resolve the problems which exist.

So we really do appreciate you being here. We really are listening to you, and we are trying to move as rapidly as possible. And I will have a chance to mention him later, but Christophe Tulou is here, who used to work right here on Capitol Hill, and he's Delaware's Secretary of Natural Resources and Environmental Control, and has also taken a strong interest in this issue. We're pleased to have him here as well.

And I look forward to the hearing. Thank you, Mr. Chairman.

Mr. SAXTON. Thank you, Mr. Castle.

Let me ask unanimous consent at this point that Mr. Young's statement be placed in the record, and, additionally, that all of the Subcommittee members be permitted to include their opening statements in the record at this point. Without objection.

[The prepared statement of Mr. Young follows:]

STATEMENT OF HON. DON YOUNG, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF ALASKA

Mr. Chairman, I appreciate your holding this hearing today on *Pfiesteria* and other harmful marine algal blooms. As many Members are aware, these algal blooms have been detected in our coastal waters for decades and have been seen from Florida to my own State of Alaska.

While the outbreaks of *Pfiesteria* near our Nation's Capital have highlighted this problem, it is not an isolated one. Congress has responded by amending appropriation bills to fund *Pfiesteria* research. What we need to do is make sure that all of the increased funding does not get focused only on the immediate problem of *Pfiesteria*, but is directed to address the problem of harmful marine algal blooms in general.

I appreciate the fears of Members with coastal districts which are experiencing this problem for the first time, but this is a national problem. It is not effective to throw money at individual outbreaks. We should look at the bigger picture and fund research into the broader harmful algal bloom issue. We need to support coordinated Federal and State peer-reviewed research on the marine micro-organisms involved in harmful algal blooms across the nation.

I look forward to learning more about how all of these algal blooms are related and whether they all react in the same manner. I hope we will also help show that Federal funding efforts must be used in a coordinated manner to learn more about these micro-organisms and what causes them to become toxic to other marine life.

Thank you, Mr. Chairman.

[The information follows:]

Mr. SAXTON. Now I would like to introduce our first panel of witnesses. Let me say at the outset one of our panelists has been delayed because of air traffic, or whatever. Mr. Daniel Baden called us an hour or so ago and said that his plane was just about to take off from a Florida airport. So we'll hear from him later in the day.

Let me introduce the members of panel one who are with us, and we thank you all for being here. We have Dr. Terry Garcia, Acting Assistant Secretary of Commerce for Oceans and Atmosphere in the Department of Commerce. He is accompanied by Donald Scavia, Director of NOAA Coastal Ocean Program; Dr. JoAnn Burkholder, associate professor, North Carolina State University; Dr. Donald Boesch, president, Center for Environmental Sciences, University of Maryland; and Dr. L. Donelson Wright, dean and director of Virginia's Institute of Marine Science, who is accompanied by Dr. Eugene Bureson, director of research and advisory services, Virginia Institute of Marine Sciences.

Let me just mention to each of you that we have those nasty little lights there in front of you. They help us stick to what we call the five-minute rule, which means that each of you has allotted to you five minutes for your oral statements, and of course in each case your entire statement will be included in the record.

I would now like to recognize Mr. Garcia for his statement at this time.

STATEMENT OF TERRY D. GARCIA, ACTING ASSISTANT SECRETARY OF COMMERCE FOR OCEANS AND ATMOSPHERE, DEPARTMENT OF COMMERCE, ACCOMPANIED BY DONALD SCAVIA, DIRECTOR, NOAA COASTAL OCEAN PROGRAM, AND JOHN STEVEN RAMSDELL, ASSOCIATE PROFESSOR, MARINE BIOMEDICAL AND ENVIRONMENTAL SCIENCES, MEDICAL UNIVERSITY OF SOUTH CAROLINA

Mr. GARCIA. Thank you, Mr. Chairman. As you noted, I am accompanied by Mr. Don Scavia, who's the Director of NOAA's Coast-

al Ocean Program, as well as Dr. John Ramsdell from the Charleston Laboratory.

I appreciate this opportunity to discuss NOAA's role in the multi-agency response to the *Pfiesteria* crisis in the Chesapeake Bay. Our efforts are focused on research and management, both supported by education and outreach. NOAA's coastal programs and research laboratories have been conducting important research related to harmful algal blooms and *Pfiesteria*, and will continue to do so. NOAA will also continue working with the States through our Coastal Zone Management Program and the Chesapeake Bay Office, as well as the Beaufort and Charleston Labs.

My written testimony describes in full detail the various activities of NOAA and our Federal partners. What I'd like to deal with today in my brief oral statement is the larger national problem that we are confronting today of harmful species that apparently are increasing in abundance and intensity in coastal waters, both domestically and internationally. These harmful algal blooms, including red tides in the Gulf of Mexico and the Southeast, brown tides in New York and Texas, and shellfish poisonings in the Gulf of Maine, the Pacific Northwest, and Alaska impact nearly every coastal state and have been responsible for an estimated \$1 billion in economic losses during the past two decades.

Blooms have decimated the scallop fishery in Long Island's estuaries, killed a billion fish in North Carolina estuaries, closed down various shell fisheries on Georgia's bank, and from North Carolina to Louisiana, and killed almost 150 Florida manatees. These harmful algae have been associated with a serious die-off of dolphins along the East Coast in 1987, and without effective means to monitor paralytic shellfish poisoning, approximately 30,000 miles of Alaskan shellfish waters cannot be harvested.

As we meet here today, Texas is responding to a new red tide that stretches along South Padre Island and the Padre Island National Seashore, and has killed an estimated 14 million fish, including Gulf menhaden, scaled sardine, Atlantic bumper, and striped mullets, as well as red drum, flounder, and sea trout.

These harmful algal blooms, which include *Pfiesteria*, are composed of naturally-occurring species that, for some reason, reproduce out of natural ecosystem balance and appear in various forms, all of which can have human health and economic effects.

The increasing coastwide and worldwide trends in bloom occurrence and intensities suggest that we must look for common underlying causes, including increased nutrient levels in coastal waters. It is also important to note that excess nutrient loads, particularly nitrogen and phosphorous, are responsible for a general overgrowth of algae in many coastal ecosystems. While these algae may not all be toxic, their death and subsequent decay can lead to severe oxygen depletion in the bottom waters of many estuaries and coastal environments.

In fact, a recent NOAA survey has revealed that at some time each year 53 percent of our estuaries experience hypoxic conditions, oxygen levels that are low enough to cause significant ecological impairment, and 30 percent experience anoxia. Those are areas where all of the oxygen is depleted. The dramatic hypoxic zone that

covers 7,000 square miles in the Gulf of Mexico indicates clearly the impact of overfertilized marine systems.

The ultimate solutions to many of the problems we are addressing here today, from Pfiesteria to the other toxic algal blooms, to severely depleted oxygen, will be based on an ability to predict the fate, transport, and impacts of nitrogen and phosphorous in coastal watersheds and water bodies. NOAA will continue to support the states and other Federal agencies in responding to this immediate, urgent problem. However, significant and lasting progress will require a comprehensive coordinated and integrated strategy to understand the factors responsible for high incidences of fish lesions and fish kills and for blooms of Pfiesteria and other harmful blooms.

NOAA and the Environmental Protection Agency are taking the lead in developing a national research strategy focused in four areas: methods to identify and detect toxins; determining toxic pathways and the means to forecast harmful blooms and impacts; developing management and mitigation options, including a rapid-response capability, and enhancing education and outreach. I will submit for the record the eight specific objectives of that research plan.

At the core of this national strategy is a multi-agency research program on ecology and oceanography of harmful algal blooms, or ECOHAB, which represents the first Federal interagency research program focused exclusively on determining the factors responsible for blooms of harmful algal in U.S. coastal waters. ECOHAB is a partnership among NOAA, the National Science Foundation, EPA, and the Office of Naval Research.

The draft national research strategy, which will be ready for review by Federal and state agencies and the academic community this month, is intended to provide a basis for developing control and mitigation strategies through our coastal management programs, which will reduce and prevent the occurrence of future harmful blooms. As evidence grows that these other blooms are stimulated by non-point sources of nutrients, our efforts with EPA and the States in the coastal zone management non-point pollution control program will be critical. For the past seven years, NOAA, EPA, and the coastal states have been working to identify programs available to address non-point sources of pollution and to ensure that appropriate management practices are applied to reduce polluted runoff. The development of state coastal non-point programs has provided a roadmap of what we need to do, and has identified existing tools and areas where more effort must be required.

The Magnuson-Stevens Fishery Conservation and Management Act also provides important tools, including the requirement that NOAA identify essential fish habitat and work with the fisheries councils to protect essential fish habitat. As we move forward in dealing with Pfiesteria and other harmful blooms, NOAA will continue to work with the states and coordinate Federal research monitoring and assessment; will lead the development to National International Agency Program that includes research to understand and predict conditions favoring Pfiesteria bloom development and toxicity as part of the national approach to harmful algal

blooms; assessment of human health and economic impacts on coastal communities and seafood consumers; further development and implementation of appropriate measures to control and mitigate these impacts, and expanded outreach efforts to ensure that coastal managers and the public can make informed decisions dealing with fish kills, lesions, and safeguard public safety.

That concludes my testimony, Mr. Chairman. I'll be happy to answer questions at the end of the panel.

[The prepared statement of Mr. Garcia may be found at end of hearing.]

Mr. SAXTON. Thank you very much, Mr. Garcia.

Dr. Burkholder, we're anxious to hear your testimony.

**STATEMENT OF JOANN M. BURKHOLDER, ASSOCIATE
PROFESSOR, NORTH CAROLINA STATE UNIVERSITY**

Ms. BURKHOLDER. Thank you, sir. The toxic dinoflagellate, *Pfiesteria piscicida*, and at least two other toxic *Pfiesteria*-like species that have not yet been named, are one-celled animals with complex life cycles and direct attack behavior toward fish. The toxic *Pfiesteria* species complex is known, thus far, from the mid-Atlantic and southeastern United States—especially from the Albemarle-Pamlico of North Carolina and the Chesapeake Bay, which are the largest and second largest estuaries on the U.S. mainland.

The dinoflagellates are usually benign little animals that consume other microbes and dissolved organic nutrients. They become toxic when they detect high levels of substances excreted by fish. Optimal conditions for toxic *Pfiesteria* activity are poorly-flushed, quiet brackish waters, warm temperatures, and high nutrient loading from human and animal wastes.

In the past seven years in North Carolina, we've lost more than 1 billion finned fish and shellfish from kills and disease related to the toxic *Pfiesteria* complex over large expanses of our estuaries. This year, these same dinoflagellates also have affected about 50,000 fish from some areas of Chesapeake Bay. *Pfiesteria piscicida*, which is best known, causes open-bleeding sore diseases, immune system suppression, and other health problems for fish.

Medical evidence also implicates *Pfiesteria piscicida* in serious human health impacts, especially for people who have worked with toxic cultures in the laboratory before we discovered that *Pfiesteria*-like species make airborne toxins that we inhale. Some of the effects, such as skin lesions, severe headaches, profound learning disabilities, and short-term memory loss have lasted for weeks to months. These symptoms usually lessen or disappear following weeks or months away from affected areas or toxic cultures.

Nearly all of the peer-reviewed published research on the toxic *Pfiesteria* complex have come from collaborations that my laboratory has developed with other Federal, State, and university scientists. As the foremost expert on these organisms in the world, I can state that comparative insights about the different *Pfiesteria*-like species are critically needed, focusing on their respective distributions, nutrient pollution controls on their toxic outbreaks, their impacts on estuary and food webs, their toxins, and their chronic as well as acute impacts on both fish and human health.

Inadequate funding for research on toxic *Pfiesteria* over the past seven years has been a restraining factor since my laboratory first discovered these dinoflagellates at major fish kills. Congress has also been slowed because a critical component, chemical analysis of these toxins, has not been given serious attention.

For the past five years, we have struggled to obtain assistance from colleagues who, despite having been sent toxins for analysis, repeatedly were not forthcoming with information about them. Toxin analysis is essential to determine whether fish from affected areas are safe to eat and the extent to which people are being hurt. My research associate and I have been seriously affected by these toxins. We have languished, and other people in our estuaries have been hurt because this information has not been forthcoming. Improved safety precautions could not be designed and treatment for affected people could not be developed.

Recently, we were able to send these same toxins to collaborators at the National Marine Fisheries Service, Charleston's Marine Biotoxin Center, through the NIEHS intramural program. Without regard for financial gain or personal accolades, these colleagues honored the issue and have worked long hours without funding support. In less than three months, they have isolated and purified water-soluble and lipid-soluble toxins from *Pfiesteria*. Furthermore, in recognition of the critical nature of this issue, they shared their information immediately.

My laboratory staff and I have forged collaborations and provided counsel for many Federal agencies, such as NOAA, NIEHS, FDA, and the EPA. We also have developed strong collaborations and provided guidance to State agencies in North Carolina, Maryland, Virginia, Delaware, and Florida, among others. We have ongoing collaborations with many researchers from universities in New England, the Mid-Atlantic, and the Southeast, bringing an interdisciplinary team effort to bear in resolving important questions about the toxic *Pfiesteria* complex, as well as other toxic algae in both fresh and marine waters, in issues of fisheries protection, water pollution control, and human health.

We also have established a network of volunteer concerned citizens. More than 300 such people in North Carolina are helping to report fish kills to us so that we can more accurately identify areas affected by *Pfiesteria*, and provide a warning system to help safeguard public health.

In my opinion, Congress can enhance efficient progress and the collective ability to understand *Pfiesteria* and other harmful microorganisms in coastal areas by funding several major laboratories to serve as centers of coordinated multi-disciplinary research efforts. We who have the experience on *Pfiesteria*, that have been tested by the yardstick of many peer-reviewed publications, critically need resources that are essential so that we can make major progress quickly.

We also need the support to provide rigorous training that is in high demand for other scientists in affected regions, and to help Federal and State agencies to provide better information for concerned citizens and environmental education efforts. Such environmental education outreach represents a pressing need to help protect public health, our fisheries, and our fishermen in affected

areas so that our citizens are able to operate from a knowledge base, rather than from panic that inevitably occurs instead when ignorance of these issues or unwarranted fear is the basis of action.

The impacts of toxic *Pfiesteria* and its close allies is an issue that I care deeply about and have worked to understand for nearly a decade. I have talked about the biology and impacts of these organisms, but a more central message needs to be related here. The toxic *Pfiesteria* complex commonly thrives in areas affected by nutrient pollution. They, as well as other harmful micro-organisms, appear to be increasing in coastal areas where urbanization, agriculture, and other human activities are threatening the health of our aquatic ecosystems. The story of *Pfiesteria* serves to illustrate that in coastal areas where so many of us live, fish health and human health are strongly linked.

It is my hope that through knowledge of *Pfiesteria* and other harmful species, we can come to a greater appreciation of the need to take better care of our coastal waters, toward protecting both our fisheries and our own health.

[The prepared statement of Ms. Burkholder may be found at end of hearing.]

Mr. GILCHREST. [presiding] Thank you, Dr. Burkholder.

Our next witness is Dr. Don Boesch from the University of Maryland Center for Environmental Science. We worked together on a number of issues before, and occasionally have been on the same boat at the same time in the Chesapeake Bay. Don, welcome to Washington. We look forward to your testimony.

STATEMENT OF DONALD BOESCH, PRESIDENT, CENTER FOR ENVIRONMENTAL SCIENCE, UNIVERSITY OF MARYLAND

Mr. BOESCH. Thank you very much, Congressman Gilchrest. We've been in the same boat in many respects, I think.

My perspective on today's subject is influenced heavily by my recent service as the Chair of two scientific committees. Late last year, I was asked by the Secretary of the Interior and the Administrator of NOAA to chair a panel of experts that conducted a national assessment. We've produced this report, and I think we've given you copies of it. The title of the report is, "Harmful Algal Blooms in Coastal Waters: Options for Prevention, Control and Mitigation." And our objective was to take this beyond the definition of the science needs, to talk about what we can do now to practically apply our knowledge to deal with prevention, control, and mitigation of the ill effects of these harmful algal blooms.

More recently, I have been called on by Maryland Department of Natural Resources Secretary John Griffin—who I believe will be speaking with you on the next panel, to chair a technical advisory committee to advise the State's agencies in their assessment of fish lesions and kills in the Maryland waters. And this committee includes notable experts outside of Maryland, as well, including Dr. Burkholder and Dr. Bureson, who are also here today.

From these vantage points, I'm pleased to offer my opinions about what is known about the effects of toxic dinoflagellates such as *Pfiesteria*, the role of human activities in stimulating them, and future research needs and approaches.

The national assessment, as I said, focused on what could be done about the ill effects of these toxic algal blooms, and these include blooms that cause paralytic and amnesic shellfish poisoning, red and brown tides, and other blooms that cause catastrophic losses of aquacultured fish, particularly in the Northwest.

Our report concluded that although pollution and nutrient enrichment have been strongly implicated in worsening algal blooms in various parts of the world, they have not yet been unequivocally identified as the source of any of these U.S. blooms that we studied. Unfortunately, we did not include *Pfiesteria* in this assessment, so we have to look at the *Pfiesteria* question a bit more carefully.

Nonetheless, we concluded that the pursuit of water quality objectives, improvements of proving water quality that involved pollutant reduction, and particularly the reduction of nutrient inputs in the coastal waters, as Mr. Garcia has indicated, might well pay off major benefits in terms of reduction of the frequency of harmful algal blooms, as well as achieve the other living resource objectives that we've set forth in the restoration of bodies of water such as the Chesapeake.

Our conclusions also included recommendations about how research can help us deal with prevention, control, and mitigation, and specifically called for Federal attention to the issue of, "How do we then take our knowledge and apply it to control, prevention, and mitigation strategies"?

Turning now to the Chesapeake, let me summarize where we are. First, after evaluating the variety of principal causes of fish lesions in the Pocomoke River that were observed starting last fall, it now appears likely that many of these lesions and the fish kills that took place this summer were associated with toxins of *Pfiesteria* or the related dinoflagellates, as Dr. Burkholder had indicated, that have been identified from these waters. The evidence has grown and increased our confidence that these are the causes of these problems.

In addition, medical researchers have documented skin rashes and reduced efficiency in short-term memory in individuals exposed to this body of water, and, more recently, some other bodies of water in Congressman Gilchrest's district on the Maryland Eastern Shore that have had similar problems. This has obviously raised concern by a quantum and resulted in a variety of steps to ensure the protection of the public health, while we learn more about the detection and cause of these problems.

The scientific team and advisors that are working on this within Maryland are turning their attention, in particular, to the environmental conditions that promote the outbreak of toxic forms of *Pfiesteria*-like organisms so that we can predict when they might occur, protect public health, thereby, and also better control the human activities that might stimulate them.

As you know, nutrient over-enrichment, particularly from agricultural sources, has been widely suspected. Maryland Governor Parris Glendening has charged a Blue-ribbon *Pfiesteria* commission that he has appointed to recommend steps that can be taken to reduce the risks. Their report is due on November 1. More effective controls of nutrient losses from agricultural activities, including the

disposition of poultry manure, are among the principal issues under review.

I believe that Dr. Burkholder would agree with me that we are still in the early stages of the *Pfiesteria* learning curve. Her contributions have been truly monumental, but there has been only a small group of scientists as she has indicated that has worked on this problem for only a short period of time, and the organism is, indeed, very complex.

With a stronger case now made for the documented health concerns, and a number of regions now more clearly affected, greater scientific research is required. I urge in your oversight role that Congress insist that this research is strategic, is integrated across the agencies and disciplines, incorporates high standards of scientific quality and peer review, and is accountable in leading to clearer understanding and solutions. From the perspective of our technical advisory committee, we've identified certain priorities for that research—and it's in my written testimony, and I will shorten it by not repeating them here.

In my opinion, though, an effective mechanism already exists to support the direction and coordinate the needed environmental research on the environmental aspects of this problem in the NOAA-led program on Ecology and Oceanography of Harmful Algal Blooms, or ECOHAB, as Mr. Garcia described. This is a program that already exists. It's national in scope; it's broadly focused, and it involves the participation of other relevant Federal agencies, as well as NOAA. I would urge your attention to advancing this program.

Finally, I'm very pleased, as Mr. Garcia indicated, that the Federal agencies have been working together to develop an integrated approach across government to address the environmental, health, and agricultural control problems.

Thank you.

[The prepared statement of Mr. Boesch may be found at end of hearing.]

Mr. GILCHREST. Thank you, Dr. Boesch.

Dr. Wright, of the Virginia Institute of Marine Science. Welcome, sir.

**STATEMENT OF L. DONELSON WRIGHT, DEAN AND DIRECTOR,
VIRGINIA INSTITUTE OF MARINE SCIENCE, ACCOMPANIED
BY EUGENE M. BURRESON, DIRECTOR FOR RESEARCH AND
ADVISORY SERVICES, VIRGINIA INSTITUTE OF MARINE
SCIENCE**

Mr. WRIGHT. Thank you, Congressman Gilchrest.

I'm not an expert on *Pfiesteria* myself. I'm here representing the Virginia Institute of Marine Science of the College of William and Mary, which includes an interdisciplinary team of 10 scientists who are studying various aspects of *Pfiesteria* and related phenomena, such as nutrients. The lead member of that team is Dr. Burreson, who is with me here today.

As you've already heard, there is much that is already known about *Pfiesteria piscicida*. However, there are at least three other species in the *Pfiesteria* complex. I should correct an error in my written statement, which refers to two; there are, in fact, four spe-

cies. The basic biology and toxicology of these other species has not been well-studied.

The species present in the Chesapeake Bay are not well-documented, but the fish kill in the Pocomoke River on the Virginia-Maryland border seems to have been caused by one of these other species, not *Pfiesteria piscicida*. Clearly, we need much more research on Chesapeake Bay species in the *Pfiesteria* complex and their impact on living marine resources. We also need more research on the broader questions of harmful algal blooms and the impact of nutrient inputs.

The Virginia Institute of Marine Science has a long history of research in the Chesapeake Bay, and the Institute is mandated in the Code of Virginia to conduct research and provide objective scientific advice to the Commonwealth and its agencies; hence, has been the leading scientific institution on the *Pfiesteria* task force in Virginia.

Our longstanding, monthly, fish stock assessment surveys in the lower Chesapeake Bay and its major tributaries have provided an early warning system for potential outbreaks of *Pfiesteria*-like organisms in Virginia. Our surveys to date have not documented an unusually high prevalence of deep lesions on recreational or commercially-important food fishes in the Chesapeake Bay, and there have been no reports of *Pfiesteria*-related human illness from eating Chesapeake Bay seafood. Thus, consumer fears about eating Chesapeake Bay seafood are unfounded, in our opinion. We believe Virginia seafood is safe.

The Virginia Institute of Marine Science has diverted existing resources to develop research capabilities on *Pfiesteria* complex organisms. We're presently culturing non-toxic stages of heterotrophic—that means animal—dinoflagellates from areas with high prevalences of lesions on juvenile menhaden. These cultures have been used to perfect protocols for identification of *Pfiesteria* complex organisms with a scanning electron microscope. We now lack only the training on specific identification characteristics to be able to provide an identification capability for the Chesapeake Bay region, but we must, very soon, obtain that capability.

There is still much we don't know about *Pfiesteria*. Federal leadership and funding are urgently needed to support future research in at least four areas that are pertinent to the Chesapeake Bay. The first has to do with identification. We need to develop scanning electron microscope capabilities for identifying *Pfiesteria* when it occurs. We also need to develop rapid molecular or immunologic diagnostic techniques for *Pfiesteria* complex organisms.

The second pertains to the general biology and ecology of the organism. We need to understand the general biology of all species in the *Pfiesteria* complex; in particular, the response that these organisms have to various environmental factors. Nutrient enrichment has been implicated as an important factor in increasing the abundance of these organisms, but the exact nature of the relationship has not been well-established yet in laboratory studies. More research is needed.

Third is toxicity. We need to determine the toxicity of all species in the *Pfiesteria* complex and the effect that these toxins have on marine life. The fourth has to do with the ecology of fish lesions.

We need to understand the distribution and the seasonal onset of lesions in juvenile menhaden in the Chesapeake Bay, in relation to various environmental factors in water quality. VIMS has elements in place to be able to accomplish all of this in Virginia. We believe that this capability must be developed within the Chesapeake Bay.

I also would like to say that I agree with Dr. Boesch that the ECOHAB program provides an effective mechanism for multi-state and interdisciplinary coordination.

Mr. Chairman, that concludes my remarks.

[The prepared statement of Mr. Wright may be found at end of hearing.]

Mr. GILCHREST. Thank you very much, Dr. Wright.

I have to leave in about 5 minutes, for about 10 minutes, and Walter is going to take over the Chair; I guess, Mike, you have a little bit more time to be here. You don't have to go at any time.

But, I'm just going to ask a few questions before I have to leave to testify at another committee. But, what I'd like to do is come back and continue asking this panel questions, so you and Mike and Eva can have at it as long as you want—five minutes.

One quick question I'd just like to ask the panel in general, and each of you, if you would like, can respond to this question. Is there any doubt at this point that *Pfiesteria* has a toxic stage, that *Pfiesteria* was the cause for fish kills in the Pocomoke—possibly King's Creek and the Chicomacomiko River, but particularly in the Pocomoke—that that toxic stage of *Pfiesteria* killed those fish in the Pocomoke and that a toxic chemical released by *Pfiesteria* did, in fact, have some harmful health effects on people? Is there any doubt about any of that at this point?

Dr. Burkholder.

Ms. BURKHOLDER. Mr. Chairman, I think I can clarify a little bit for you. There is, as has been mentioned in the panel, a toxic *Pfiesteria*-like species; in fact, we have found two toxic *Pfiesteria*-like species in the Pocomoke estuary at this time. Dr. Steidinger, from the Florida Marine Research Institute, is a foremost taxonomist on dinoflagellates. She and I are working together to cross-compare and cross-corroborate our species analyses, and we feel that it's premature at this time to say which member of the toxic *Pfiesteria* complex was present, but two—actually two toxic species were. So they haven't been named, particularly, but they're definitely there.

We have also verified that these toxic species could kill fish and culture fairly rapidly, after we received the samples, indicating that these species were indeed toxic in the Pocomoke estuary and were hurting fish.

It is always very difficult to establish certain causality in a field setting, but from our data I would say that we are 95 percent certain that two toxic *Pfiesteria*-like species were there, that they caused fish problems, and that the problems experienced by humans who were in that estuary at the time of these fish kills are extremely similar to the problems confronted by humans working in a laboratory setting with *Pfiesteria*. It's much easier to demonstrate causality in a laboratory environment, and the symptoms that were sustained by laboratory workers were very, very similar to what was sustained in the Pocomoke.

Mr. GILCHREST. Mr. Garcia?

Mr. GARCIA. I would agree with Dr. Burkholder and would ask that Don Scavia, who is accompanying me, elaborate. The chairman had earlier elevated me to the ranks of these scientists by referring to me as "Dr.," and although I appreciate it, I'll have to decline the promotion. But I would ask that Don Scavia—

Mr. SCAVIA. Mr. Gilchrest, there's actually not a whole lot to add to what Dr. Burkholder has just said. It is clear that there is a *Pfiesteria* complex out there.

Mr. GILCHREST. When you say *Pfiesteria* complex, you're talking about a series of these little, tiny creatures that are cousins.

Mr. SCAVIA. That's right.

Mr. GILCHREST. But not brothers or sisters.

[Laughter.]

Mr. SCAVIA. I think we'll stop with saying they're cousins.

Mr. GILCHREST. Okay.

Mr. SCAVIA. And they are certainly indicted in this whole episode. But beyond that, I think the work that is being done with Karen Steidinger in Florida and in JoAnn's lab to try to nail down which species we're dealing with is critical.

Mr. GILCHREST. But it is your conclusion that a tiny micro-organism, with whatever name—some aspect of the start of the food chain—does react with a certain toxic stage for the purpose, we guess, of stunning fish so they can go in and feed, and then that toxic chemical remains in the water? And if people go in the water near the time that that happened, they could have, or they do have, some health effects?

Mr. SCAVIA. That's my understanding. I think JoAnn can actually elaborate on that.

Ms. BURKHOLDER. I can make a couple of other points. One is that the laboratory exposures that were sustained were predominately from inhalation of neuro-toxic aerosols—airborne toxins from these organisms. And in the field setting, it looks as though the same kinds of effects occur. These toxins are fairly short-lived when they're in the water or the air, based on our research to date, but there are both toxins in the water that can cause trouble for humans, and also toxins in the air that people can inhale.

When fish stop showing signs of distress, when they stop developing erratic behavior or lesions or open-bleeding sores—when they stop dying—the toxins that are in the water rapidly break down, so these *Pfiesteria*-like species have to keep making toxin in response to fish. The toxins don't last very long in the water.

Mr. GILCHREST. So if the fish aren't present, they're not likely to release this toxin.

Ms. BURKHOLDER. That's true. These organisms are usually benign little animals, and they only become toxic—to date, based on our research—when they are in the presence of a lot of excreta from fish. I don't think it's any accident that menhaden have been the species that are affected in both North Carolina and Maryland waters, predominantly. About 90 percent of the fish that have died have been menhaden.

Mr. GILCHREST. If a large number of menhaden are in a certain area where there is this *Pfiesteria* complex and this triggers the toxic stage of this *Pfiesteria*, if the fish then become stunned and

actually die and then probably stay there, does the *Pfiesteria* then persist over a long period of time in its toxic stage?

Ms. BURKHOLDER. *Pfiesteria* is only interested in live fish when it's toxic, and once fish die, they transform; they convert like a caterpillar changing to a butterfly into stages that don't look anything like the little stages that were in the water, but those stages attach to fish and begin to feast on the carcasses or the remains of the fish; they're not toxic anymore.

Mr. GILCHREST. Then they revert back to a different state. What's the time frame for all that to happen?

Ms. BURKHOLDER. In the laboratory with extremely toxic cultures, fish can die within ten minutes. Out in the field, we have what we call sudden death fish kills sometimes from *Pfiesteria*-like species, in which many fish can die within four hours.

Mr. GILCHREST. So, the *Pfiesteria*, though, stayed toxic for about the same amount of time?

Ms. BURKHOLDER. Yes, they do. Menhaden, as I mentioned, do everything wrong. They are big; they travel in big schools; there are many, many fish in a school; they're very oily; they have lots of excretions, and they linger to feed in poorly-flushed areas where a lot of their excreta will accumulate and stimulate *Pfiesteria*.

Mr. GARCIA. Mr. Chairman, can I make one point?

Mr. GILCHREST. I'm going to have to run, so I'm going to turn it over to Mr. Jones. I'll be back, hopefully, in 10 minutes.

Mr. GARCIA. I wanted to make one point that this highlights. This exchange that we just had highlights the need for the continuing research that all of the individuals here have been conducting and those on the later panel will talk to you about. Also, to note that Dr. John Ramsdell, who is with me, has been conducting research into identifying the toxin, which is a critical step in dealing with this problem, identifying and then characterizing that toxin so that we know what we're dealing with at the time that we have an incident of fish lesions or fish kill. Dr. Ramsdell will be available to answer questions, if you would like.

Ms. CLAYTON. Mr. Chairman, may I ask a question?

Mr. JONES. [presiding] Yes, ma'am. The lady from North Carolina.

Ms. CLAYTON. I just wanted to inquire, and the whole assumption of the nutrient-rich environment that enhanced the possibility of this toxin, *Pfiesteria*-like organism, has the agriculture community nationally been involved with you in terms of research? I know we've just added, if that assumption is there, I would assume that we should begin having an integrated approach to this thing. Testimony suggested that the research need would be made and the assumption is that there is nutrient enrichment that gives great enhancement. I was just wondering, to date, is there any research from the agricultural community that's integrated into the research, Dr. Burkholder?

Ms. BURKHOLDER. No, not yet. I would welcome the opportunity to work with agriculture, but thus far, I have not been asked to participate in such research. I think it's important to note—I do appreciate the spirit of your question—I think it's important to note that it isn't, of course, just agriculture, but it's other sources of pollution too that can encourage *Pfiesteria*, such as urban runoff, and

I think Congressman Jones will have more questions about nutrients in general, but I'll just start it off with that comment.

Ms. CLAYTON. Okay, thank you.

Thank you, Mr. Chairman.

Mr. JONES. Yes, ma'am.

Dr. Burkholder, I'm going to address my questions to you, but obviously, I think maybe Mr. Garcia might respond, on one of the questions, the first question. When you mention 1 billion fish, I believe that's correct in your statement, as well as Mr. Garcia's statement, have died in the North Carolina waters, is that correct? Tell me—excuse me, I'll let you answer, I'm sorry.

Ms. BURKHOLDER. Yes, it is.

Mr. JONES. Tell me how you determined the accurate number of 1 billion fish. I mean, I'm a non-scientist obviously, but that really raised a question in my mind. How can you verify 1 billion fish? How do you go about—what's your process of verifying?

Ms. BURKHOLDER. In the old days, when we first began this research, we were relying heavily upon the Division of Environmental Management, especially the Washington regional field office. They, it is my understanding, used fish counting methods that are from the Wildlife Resources Commission of North Carolina and it was their estimate, sir, that I was using, not our own. Now that we have been involved with fish kills a great deal in the past seven years, we are using American Fishery Society's standardized and certified methods for counting for fish. They're still pretty rough.

Out in the field when fish die, they often get scooped up by gulls even as they're dying or they get washed away or blown away across waves. So often those results are reported on the average by the thousand; can't get much more accurate than that. But the 1 billion estimate was—it sounds like a lot, but let me tell you the circumstances involved.

That kill occurred in 1991 from September to October, over a six-week period. That fish kill in the Pocomoke, it affected very small menhaden; they were only three or four inches long and they had almost—I think 98 percent of them were killed with open, bleeding sores. So, it was a big expansive area, about 20 square miles over about eight weeks, with very small fish that kept coming up and dying.

Mr. JONES. Thank you. Let me—the additional questions, since you mentioned the seagulls, has research been done on species which feed upon the affected fish?

Ms. BURKHOLDER. I wish I could tell you yes. We're just beginning some collaborations with the Food and Drug Administration, Dr. Sherwood Hall, in particular. We've been feeding infected oysters, that is, oysters that we've deliberately been feeding toxic *Pfiesteria* to, to see whether they would affect fish that consumed some of the oyster tissues. So far, the results are good from what I understand; there is no affect on fish that are consuming those infected oysters.

To really nail that question down, we must know the chemical identities of the toxins, so, otherwise, we can't tell you where exactly the toxins go—if they're taken up by fish, whether they're broken down, whether they're allowed to accumulate, and so forth. What I can say that's encouraging, at least, unfortunately, it's an-

ecdotal, but it does provide encouraging news, such as wildlife do not seem to be affected by eating *Pfiesteria* or related fish kill fish. They can consume a lot of fish with open, bleeding sores—gulls, blue crab, and other species of animals—without any apparent problems. That's very unlike some of the other toxic algal problems that occur worldwide.

So what I think may be going on is that these toxins are so lethal to fish so quickly, that they cause fish to look bad, to become diseased, and the skin peeling, and so forth, so quickly that folks would tend to leave those fish alone and probably those fish die so fast that I'm hoping they don't accumulate much toxin to begin with.

Mr. JONES. Let me ask—

Mr. GARCIA. Excuse me.

Mr. JONES. Mr. Garcia?

Mr. GARCIA. Just to elaborate on one point, as Dr. Burkholder said, the research on *Pfiesteria* is still ongoing and incomplete regarding bioaccumulation of the toxin in the food chain. There is evidence, however, that with red tide and other harmful algal blooms—and we have a map showing the incidents of these blooms around the country, there is bioaccumulation. For example, in shellfish, we also detect the dieoffs of manatees and dolphins as a result of red tide, and we feel that there is a relationship of all of these incidents connected around the country to nutrient loading into the system. Obviously, additional research is going to have to be done on the specific question, as does *Pfiesteria* bioaccumulate, but we do know that in other incidents that red tide and these other problems, that it is clearly a link in the food chain.

Mr. JONES. Thank you. Just one or two other quick questions. Dr. Burkholder, I believe that Dr. Wright said, as it related to the fish in the Chesapeake or in the Virginia waters, that they were safe to eat. Would you say the same thing about the fish in North Carolina?

Ms. BURKHOLDER. I'm really glad you asked that. It's part of what I was alluding to in my testimony about a very pressing and critical need for environmental education of our citizens. Hindsight always has twenty-twenty vision, but if we could just educate our citizenry enough, they would not be responding from more of panic constraint, but instead on the basis of knowledge. The fish in almost the entirety of the Chesapeake Bay were very safe, from *Pfiesteria*-related problems anyway, even during the time that the Pocomoke actually was shut down. The State of Maryland acted, in my opinion, very proactively by just making sure that none of the fish from the affected area, even if they would have been safe for human consumption, were allowed to go to market. Unfortunately, because the public doesn't understand these issues very well, a panic ensued anyway and it's so unfair for the State of Maryland fishermen for that to have happened.

In North Carolina, I can say, that when there are no fish disease events or fish kill events related to *Pfiesteria*-like species, of course those fish would be safe from *Pfiesteria*, yes.

Mr. JONES. I thank you. My time is up. The gentleman from Delaware, Mr. Castle?

Mr. CASTLE. Well, thank you, Mr. Chairman. Let me just ask Mr. Garcia one question. Maybe he can be brief, because I want to get to the others on some other questions. Perhaps you could outline for us—this is sort of a broad question—but I think it's important for all of us to understand what the Federal Government is presently doing to coordinate with the States on Pfiesteria and other harmful algal bloom research and monitoring and what Federal funds may be available. Perhaps the people here know, but I think it's very important that we hear that so we know that coordination is taking place.

Mr. GARCIA. Well, very briefly, it's a three-prong strategy dealing with near-term, mid-term, and long-term needs. In the near-term we have been providing assistance to the coastal states to deal with the monitoring and assessment needs of identifying the Pfiesteria toxin and dealing with fish lesions and outbreaks of fish kill. We have provided assistance with the Environmental Protection Agency to the State of Maryland to assist them in a rapid response in the event of a fish kill or the detection of fish lesions.

Near-term, the work is focusing on identifying the toxin, its characteristics, its causes. Long-term is identifying or dealing with the larger issue of harmful algal blooms, their causes, and mitigation and control strategies, so that we can assist states in dealing with this problem—or these problems, rather—as we confront them around the country.

Mr. CASTLE. A very fast followup is that (a), are we responding to crises into problems or is this now an ongoing kind of funding and research effort by the Federal Government, which I believe it should be?

Mr. GARCIA. Yes, it's probably a little bit of both, but the research has been ongoing for a number of years. This Pfiesteria problem is not new. Dr. Burkholder has been working on this for many years. The Federal agencies, NOAA in particular, have been following and researching this as well. And the larger problem of harmful algal blooms has been an issue which we have been very concerned about at NOAA and in the administration for the last several years, and as was noted, commenced this interagency effort to understand the problem of harmful algal blooms.

Mr. CASTLE. Thank you. Let me turn to all those who have doctors preceding their names here, the real scientists in this. I guess I'm a little more uncertain after hearing you than I was before. After listening to Dr. Burkholder last week in Delaware and reading about this as much as I could, I thought I sort of understood it better than I realized I do now. My concern is as somebody representing a district and somebody's worried about all the issues that you know people are going to worry about. What are the causes and what do we have to do to prevent it? I thought that the causes were fairly certain. Obviously, there's a fish coming into the area causing these organisms to become toxic; that's pretty clear, but I thought that warm water was a factor, enriched nutrient levels were a factor. The factors in that were probably point and non-point sources. But, I'm not as sure about that after hearing all of you, and apparently there's a little more scientific uncertainty about all of this, and obviously, what we have to do to prevent it is to correct some of those problems, I suppose.

I'm interested in your as precise opinions as possible as to potential causes to why this is happening at different times in different States and most of what I hear about are East Coast States. I don't know if some of the—I've seen these maps; I saw them with national magazine first and some show problems perhaps of algae-related problems in other parts, but the Pfiesteria problem, to me, seems to be mostly in East Coast areas and generally in a fairly limited vicinity, I guess North Carolina being the—North Carolina and Virginia and Maryland, Delaware, and those areas.

I'd be interested in your views on the causes, and be fairly bold in your answers. I mean, I want you know you need scientific backing, but we need to know what's going on here.

Ms. BURKHOLDER. Congressman Castle, we have done a great deal of research in the laboratory and some field research which strongly indicates that, under the right conditions, Pfiesteria-like species can be stimulated by nutrient overloading and they are the factors that you're alluding to. They are poorly flushed, poor flushing, or poorly flushed areas; fairly warm temperatures; the right salinity, and then a nice rich nutrient background encourages their growth. What is uncertain is the amount of nutrient loading, number one, that can begin to promote the problem, because Pfiesteria tends to occur and cause the most trouble in known nutrient-degraded waters.

What level does it begin to have a problem at we are not certain yet. What are the interactions of organic and inorganic nutrient loading and all the different complexities of the forms of the nutrients that can stimulate Pfiesteria-like species, we're not certain of yet. We know that both organic and inorganic enrichments can encourage it, but they're just all kinds of quantitative information to nail down exactly where the problem will begin, under certain swell conditions, that we need still to—

Mr. CASTLE. But, that is part of your ongoing research? Is that correct?

Ms. BURKHOLDER. Yes, it is.

Mr. CASTLE. A substantial part of your research?

Ms. BURKHOLDER. That's the area of emphasis that I care about the most, although in the past three years I have had to devote almost all of our attention, with extremely limited funding, to toxin analysis, just growing enough of the organism to make toxin.

Mr. CASTLE. Perhaps the others have a comment.

Mr. BOESCH. Yes, if I may address that—as I mentioned, I chair the technical advisory committee which Dr. Burkholder is on, and we met for the first time in early August. To answer Congressman Gilchrest's question and yours, too, when we first met, based upon the evidence we had about the Pocomoke River at the time, there was a lot of doubt about whether Pfiesteria, or Pfiesteria-like organisms, were cause of the lesions. And all of us concluded, Dr. Burkholder as well, that we weren't certain about this, but it seemed to be something we should look into more carefully. Since that time there's much more evidence been gained, so I wouldn't say there's absolutely no doubt, but I would say there's very little doubt that what we've seen in the Pocomoke River and the other rivers of the Maryland eastern shore this summer is related to toxins produced by Pfiesteria-like organisms.

Secondly, with respect to your question about the role of nutrients and non-point sources. Obviously, as you know, the whole Delmarva Peninsula has extensive agriculture and heavy loadings from agricultural non-point sources. So obvious attention is brought there, particularly based upon the results that Dr. Burkholder briefly reviewed that she's produced in North Carolina. Now, obviously, if we're going to take major steps to control those, there's a burden of proof that we need to apply. So what we're doing right now in our technical advisory group and through Governor Glendening's citizens commission, is providing technical advice, pulling together the results that we have, not only from Dr. Burkholder's laboratory, but from other—

Mr. JONES. Excuse me, I apologize for interrupting. We've got about seven minutes to get to the floor for a vote. Then we have a second vote, which is called a 15-minute vote. Then we have a five-minute vote. Certainly, we will recess for the time being. We'll let this panel come back and then Congressman Castle can finish this line of question and answering. So, we will recess for about 20-25 minutes. Thank you.

[Recess.]

Mr. GILCHREST. [presiding] The hearing will come to order. We have a series of three votes. Members will be in and out during the course of the rest of the hearing, but we thought we would proceed, so those of you who have to travel, your travel plans will not be disrupted.

So, what I will do is begin the questioning, I guess until I run out of questions, and if they're not back, then this panel would be dismissed.

I do have another question for—one of the questions I asked before I had to leave was dealing with the fundamental question: Is there a *Pfiesteria* complex that emits a toxin that kills fish and is harmful to humans? Is there anybody else that wants to make a comment on that?

Mr. BOESCH. Congressman Gilchrest, just to reiterate what I said a little bit after you left in response to your question. To keep this in perspective on how quickly we're having to learn about what's going on and improve our scientific understanding and advice, I commented that in early August, as you know, we held a meeting to bring all this information together. At the time, the technical advisory committee said it's certainly possible, but it was highly uncertain that the fish problems, the lesions and the like, were caused by *Pfiesteria*-like organisms. Since then, in a period of just about a month, we had the fish kills, we had more direct observations and measurements, and we had more positive identification of *Pfiesteria*-like organisms from the Pocomoke River.

Our committee—and again, as I mentioned earlier, Dr. Burkholder's been a very valuable participant on it came to the conclusion that—it's in answer to your question. You said, "is there any doubt," and I said, "well, it's hard to say there's no doubt, but it's certainly little doubt that what we've seen, at least in some of the kills we've had this summer, was related to *Pfiesteria*-like organisms and their toxic effects."

With respect to the health effects, I'm certainly not qualified to evaluate that evidence, but I've heard a lot of results presented, I

think as have you, that concern the cognitive tests of individuals who've been exposed and the interpretation that they've had, reduction of the efficiency of their short-term memory. The evidence is certainly building from individuals who have been exposed, not only in the Pocomoke River, but in the two other eastern shore rivers. Now, that has to be viewed in the context of the other observations, not only of the laboratory researchers in North Carolina, but of many people who have been exposed potentially to these toxic organisms in North Carolina and the concerns raised by the primary care physicians who treat them.

Mr. GILCHREST. Dr. Wright?

Mr. WRIGHT. Congressman Gilchrest, I'd just like to also follow up with a clarification of a news report that apparently was heard this morning on public broadcasting, that said that Virginia had concluded that there was no human health effects, negative human health effects. That was a serious misrepresentation. That is not a Virginia finding. I think if I may, I'd like to let my colleague, Dr. Bureson, comment further on that.

Mr. GILCHREST. Dr. Wright, there was a story in The Washington Post this morning. Is that the same story that you're referring to?

Mr. WRIGHT. That's probably the same one, yes.

Mr. GILCHREST. For those who may not have seen that, the Post article basically says that a Virginia health official said yesterday that tests on four people who believe they were suffering from exposure to *Pfiesteria*—basically, the Virginia health official came to a conclusion that those health effects felt by those four people was not due to *Pfiesteria*. That's what the paper said.

Mr. WRIGHT. Well, that's the case. Those four people were not affected, but that does not mean that one can conclude that there is no health affect.

Mr. GILCHREST. I see.

Mr. WRIGHT. It's a more general question than that, and it certainly—Virginia has no evidence that says that *Pfiesteria* is not harmful.

Mr. GILCHREST. Did you want Dr. Bureson to respond?

Mr. WRIGHT. I don't need it.

Mr. GILCHREST. I guess, from—

Mr. GARCIA. Mr. Chairman?

Mr. GILCHREST. Yes, sir?

Mr. GARCIA. Could I ask that Dr. John Ramsdell, from our Charleston lab, just address one point on the status of the work to identify and isolate the toxin, because I think that it's an important issue and would be helpful to understanding where we are.

Mr. GILCHREST. Certainly, we'd like to hear that.

Mr. RAMSDELL. Well, sir, at this point in time I can tell you with certainty we do not have the final answer, but I am very pleased to be able to give you an assessment in terms of where we are at the present time, in terms of our efforts to be able to define the toxic material that's produced by this organism, as well as our efforts to be able to provide a means to effectively assay or detect the material from various sources.

This work really has come about in a very productive collaboration between several institutions and has been a very productive one at that.

Mr. GILCHREST. How long has this collaboration gone on for, as far as this issue is concerned, and who are those institutions?

Mr. RAMSDELL. This collaboration actually involves the NOAA Marine Biotoxins Program, Charleston; Dr. Burkholder's laboratory, North Carolina State University, and the Intermural Program of NIEHS.

Mr. GILCHREST. How long have you been doing this?

Mr. RAMSDELL. This collaboration?

Mr. GILCHREST. With this intermural program and your lab and Dr. Burkholder?

Mr. RAMSDELL. Yes, this basically has been conducted as three, two working groups in which we have gotten together for two three-day periods, working together, collaboratively, side-by-side, at the bench. During—

Mr. GILCHREST. Was this recently? Was this in 1997, 1992? How long is?

Mr. RAMSDELL. The first collaborative trial took place in July of this year; the second collaborative trial took place in August.

Mr. GILCHREST. And the conclusion was that there's certain uncertainty?

[Laughter.]

Mr. RAMSDELL. I wouldn't want to be on the record for saying that. Basically, what we have been able to determine is that there is a water-soluble substance produced by this organism and this water-soluble substance has properties that would suggest that it may interact with the nervous system. Key to being able to identify a toxin is a means to be able to detect it, a method to detect it, because these things are not visible. You need to have some biochemical means to define it.

Basically, the approach that we took, what was based upon some earlier studies that we had done, where we treated an animal with a toxin; we injected a toxin in a mouse, and then we extracted from it's brain the genes that would be induced by that toxin. We identified one gene that looked very promising, and so we took the human analog of that gene and isolated the part of the gene that would be induced by the toxin. We then ligated that part of the gene to a gene from the firefly that is responsible for catalyzing formation of light. We then took this hybrid gene and expressed it back into mallanlian cells. Then we found a cell type that, when they were exposed to the toxic organism or the water-soluble material from that organism, that these cells gained the capacity to generate light through enzyme pathways. This was used as a very sensitive means to be able to track the toxin and this is the key to being able to lead to undergo our purification steps—to be able to follow it through these long columns and all these different means which lead to a purified molecule. We are not at the stage right now where we have a purified molecule. We are close.

Nonetheless, we have been able to find that this activity does, indeed, correspond to the ability to kill fish in a tank, and so it is promising in that regard, but until we actually can indeed say that there is one molecule that behaves in this assay the same way it affects fish, we cannot be certain.

Mr. GILCHREST. I have one more quick followup question, if my colleagues will be patient with me for just one more minute, and I'll yield to Mr. Jones.

Can you give us some timeframe when you will be, when you have isolated that molecule, when you will have some clear understanding of the toxicity of that molecule and what it does? Is that a month from now, a year from now?

Mr. RAMSDELL. Well, it must be recognized that's very difficult to do. During this process when you're dealing with an unknown substance, there is no good way to predict how it's going to perform in your next step. One thing we can say in terms of detection methodology is that we feel we are at the point now where we're quite satisfied with the development phase and we want to be able to take the next step, which is validation. That is to be able to really determine how reliable that this method might be as a predictor in terms of whether or not a bloom is occurring or a predictor in terms of whether or not an individual truly has been exposed.

Mr. GILCHREST. So, you started this in July?

Mr. RAMSDELL. Yes, sir.

Mr. GILCHREST. Is there some reason why it wasn't started in July of 1992, or 1993, or 1994? You don't have to answer that now. I yield to the gentleman from North Carolina.

Ms. BURKHOLDER. Actually, I could comment on that. We had basically been working with other researchers and had given them a lot of toxin in 1992, again in 1993, 1995, and the way that we had conducted this research, the individuals who were involved, had asked if they could be, basically, the people who were working on the toxin. So, at the time, we had forged that collaboration, but we could not seem to get much progress made. So, finally, we couldn't get any kind of information from those folks when we gave them toxin and finally decided that we really had to go on to other people, so we forged this collaboration.

Mr. GILCHREST. Thank you, Dr. Burkholder. I guess we can get into that issue a little bit later.

Mr. Jones?

Mr. JONES. Thank you, Mr. Chairman. I had a chance to ask the majority of my questions prior to the recess, but there were two. Dr. Burkholder, I hate to keep coming back to you, but this is new for me, meaning being so involved with the North Carolina problem. How many assistants do you have in the research your doing in North Carolina?

Ms. BURKHOLDER. Right now, we have one full-time research associate in my laboratory, who is paid for as a full-time, full-benefits, permanent person, with North Carolina State funding. Unfortunately, it happens to be my research associate who was hurt by these organisms and is not allowed in the facility to work with them. So that research has to be conducted remotely; whatever he does has to be conducted in our laboratory and he cannot participate in growing toxic cultures and taking care of them. All of the rest of the folks in my lab are paid for by soft monies, that is, whatever research we can pull in from grants, and right now we have, on a temporary basis, from grant to grant, I think three folks who are in my laboratory as full-time technicians.

Adding fish, seven days a week, round the clock, changing live fish with dead fish, having to dissolve the fish in bleach before we dispose of them in special biohazard facilities. The disposable gloves, boot, hair covers and other materials just to work with these organisms safely, costs about \$40,000 a year, and this research is being conducted in a small trailer with a backup power generator.

Mr. JONES. Thank you, and my second question, and the last will be: If you were in the Congress, or if you could recommend to the Congress—and this is for the entire panel—how would you suggest that the Federal Government could help facilitate and coordinate the research that is being done in the different States by the different universities? I mean, obviously I realize what NOAA's doing, Mr. Garcia, and appreciate that very much, but I guess, do you feel that the coordination and cooperation, I'm sure it's very good, but it could be done better? What would be your suggestion to this panel?

Ms. BURKHOLDER. My suggestion, as I had said earlier, would be to try to especially fund some centers—I think the Chesapeake certainly needs a center; the Albemarle certainly needs one at least—in which the research centers can function as integrative, coordinative effort bringing in multidisciplinary teams of people especially and including at least folks with a lot of expertise on these organisms, so that the questions can be quickly answered or at least more quickly answered than if we start from scratch in terms of our basic understanding of these organisms.

I hate to leave this just with Pfiesteria, though. There are a lot of harmful algal species, and so there needs to be some very concerted research efforts in other regions and even in these regions for some of the other harmful organisms that we have. I do applaud what Mr. Garcia has suggested in terms of ECOHAB, the multi-agency bringing together of research funding for peer-reviewed research on these organisms, not just Pfiesteria, but others.

I would also, however, hope that the collaborations that have been forged with State and Federal agencies would continue to receive some—well, actually would begin to receive some—strong funding. We have not seen that yet.

Mr. JONES. Thank you. Thank you, Mr. Chairman.

Mr. GILCHREST. Thank you, Mr. Jones. Mr. Castle?

Mr. CASTLE. Well, thank you, Mr. Chairman. I had a chance to ask questions before, but I thought Mr. Jones' questions were excellent and exactly what I sort of wanted to talk about, too.

I think, while we probably have in this room right now, just about the leading experts on Pfiesteria in this country, and to find out a whole lot after, you don't have to belittle anybody else, but this is not a field that has hundreds of thousands of researchers out there. This is not the latest nylon or whatever it may be. As a result, I think it's really, really important that if we do nothing else today, that we afford you the opportunity to talk to each other and to tell us what you need, as you just did in answering Mr. Jones's question, what we need to do to help you with respect to the research.

I mean, I worry that we're going to—and we started to do some funding; we've had some amendments approved. We have \$11 mil-

lion in different programs and we passed them in the House, because we're concerned about this, but I'm worried that, you know, we're going to put \$40 there and \$30 there, or whatever may be and it's going to be out at the University of Delaware and Maryland and North Carolina State, and whatever may be, and you get no coordinated effort out of it. There's some excellent publications here; I think you all, on very limited resources, have really done some exceptional research work and some exceptional reporting work, but I have learned from this hearing, and knew before, there are also a lot of open questions that we have to get answered out there.

It seems to me the best thing we can do is probably put all of you in a research lab someplace and throw away the key—maybe let you out on the weekends, whatever, maybe, and have you all talk to each other and coordinate. I worry that we lose that, even in the day of computers, we lose that when you all go back to your various locations.

So, I would hope, Mr. Garcia, and to the various academics and researchers here, that we would have a real devoted effort. In my understanding, the timing of the *Pfiesteria* outbreaks is it's usually a late spring, summer, early fall-type circumstance. So we probably have a little bit of time now in which we can get some collaboration on some of the details of the research and hopefully elevate all this a little bit there so we can have it.

I'm not being critical, because I think this is—in fact, I think the response has been tremendous to this particular problem. It's been outstanding, but there's still enough open questions I really think we need to make sure we have that coordinated effort and that we as Members of Congress don't go off on tangents either. You straighten us out if we start to pass unnecessary or duplicative amendments or cause you to go down some path that isn't helpful to what you are doing.

I mean, you're welcome to comment on that if you wish, but that's my judgment and what I would like to see come out of this. Dr. Boesch?

Mr. BOESCH. I'd like to comment on it. I think it's an excellent point. As I said in my testimony, I think, whatever resources you provide, you should hold the agencies and the scientific community accountable. This is a challenge for us because of the sense of public urgency and the difficulty of the problem. As I said, I would hope that we, however, not lose sight of the things that provide excellence in American scientific tradition, that is peer review and holding to high standards of quality.

With respect to the coordination, I think we're seeing several things which are promising. First of all, on a Federal level. I think in part inspired by a conversation that our Governor Parris Glendening had with the President at a school event, the next day the alarms rang and there was a meeting of top-level Federal agency people to begin to coordinate their efforts. I think that's a very positive sign.

Secondly, with respect to the scientific community outside of government, you're right. We've tended to be somewhat parochial at times, and particularly with respect to research in estuaries. We have worked with our colleagues in Virginia because we share the

same Chesapeake Bay, but we've often approached our science as, you know, Chesapeake Bay science and Albemarle Pamlico Sound science, and Delaware Bay science. We need to do better than that. So this is going to be a challenge for us to do that.

We've made one advance on this problem, when problems were identified in Maryland waters Secretary Griffin, who will be talking to you later, actually appointed a committee that includes not just Maryland scientists, but scientists from Virginia—Eugene Burrenson is a member of that—and from North Carolina and South Carolina. So, we already have at least the beginning of a mechanism to begin to share our experiences and to talk about how we can work together across those State and watershed boundaries, if you will.

Mr. GARCIA. If I could just make one point, I thought your point was excellent. We have to maintain a sustained research effort in this field. We have, I think on relatively limited resources, accomplished quite a bit through ECOHAB and now through the combined Federal-State effort to deal with the Pfiesteria problem.

I would also point out that it's difficult to overstate the need to focus on non-point source pollution and dealing with that problem. Whether or not Pfiesteria is linked to nutrient loading, whether or not some of these other problems are, it is a no regrets policy or approach. You will see an improvement if we can control and mitigate the impact of non-point pollution, and so I would suggest that, in addition to the research, we also need to devote resources to assisting the States, and this is a key point, assisting the States in developing their programs, because it has to be done on a State and regional level, developing their programs that will control non-point pollution.

Mr. CASTLE. Thank you.

Ms. BURKHOLDER. If I could add one comment to that, I do very strongly agree with Mr. Garcia. Although the verdict is out on a lot of these algal species, we have highly-correlated Pfiesteria increases with both human sewage and swine waste in some of our field work. So, there's a case to be made for the role of non-point pollution to at least be further investigated and stressed in some of research efforts to resolve these questions.

Mr. CASTLE. And of course, there's always side benefits, other benefits, just as in the Pfiesteria, with respect to that.

I appreciate all of your answers and I do think you're doing a good job. I feel like a coach who's team is fighting to come back—you've done well; we've got to do a little bit better type thing like that. I'm not critical at all, but you know, we do need to talk to one another. So I do appreciate all the interest.

I yield back.

Mr. GILCHREST. Thank you, Mr. Castle. I just have two quick followup questions.

Mr. Wright, in your testimony you stated that the number of fish with lesions in the Chesapeake Bay was not unusually high for this season. I've heard a number of other people make that same statement, and I would guess that it's probably fairly accurate. Yet, we see a great deal of information across not only the East Coast, but the West Coast, about algal blooms, about the Post a little while ago had an article dealing with 162 dolphins washed up on the

beach off of Mexico and they felt that it was some toxic one-cell plant; pelicans in 1991 in southern California, 22 in 1984. Well, in 1984 we began to hear about the problems in North Carolina; and then apparently in Canada, Prince Edward Island, three people actually died and 100 people were sickened by five kinds of seaborne toxic algae.

Are we just better at finding these things? Have they always existed to this degree where they've been harmful? Are we increasing the number of these incidents since, let's say, a certain timeframe in the United States, because of nutrient overload? I don't know if that's too vague a question, but—

Mr. WRIGHT. No, it's a very good question. I think there are at least four aspects to the lesion question that I probably should address. The first is that there are many causes of lesions on fish. The second is that our trawl surveys, which go back many years, so we have a historical record and we have people on the trawl surveys who are accustomed to recognizing fish with lesions and to reporting these causes, and they see lesions on fish every year during the summer months.

The third point is that most of the lesions have appeared on menhaden this year. Out of a trawl survey that was conducted about two or three weeks ago to look more closely at the possibility of *Pfiesteria* in the Rappahanock River and other estuaries, something just under 12,000 fish were recovered in those trawl surveys, and of those 12,000 fish, .4 of 1 percent had lesions. So that's a reason to say that it's not unusually high, but—

Mr. GILCHREST. I wouldn't argue with that. I think Maryland DNR showed pretty much the same statistics as you're describing here. I guess my question is, have these things always—is there an increase in the number of harmful algal blooms? An increase in this type of dinoflagellate, *Pfiesteria* complex in the last 20, 30, 50 years? Can we document that there's a surge in this or has it always happened and we're just better at identifying it?

Ms. BURKHOLDER. I'd like to make a couple comments. One is that we have only known that toxic *Pfiesteria piscicida* and its close relatives were in the water killing fish since 1991. So we have a very, very poor historic record. We've been working in my lab for seven years on this in the field, but the only way that it came to our attention was because these little culture contaminants began to affect fish in the vet school at North Carolina State University. In other words, we found little organisms with attack behavior toward fish, a very bizarre kind of phenomenon. If we hadn't seen it because of an accident in culture, we wouldn't have even known enough to look for it out in the field. So, we have a very short historic record on *Pfiesteria*.

At least in the Albemarle-Pamlico, I can tell you that old-time fishermen have said that there have been kills such as the ones we've related to *Pfiesteria*—one in maybe the late 1970's, but mostly since 1984. They've told me that there are many times that fish have died, like menhaden, and small schools in canals in our State. They go into these canals, run out of oxygen, and they're not considered very bright fish, so they don't leave, and they die.

But the kinds of kills that I'm talking about are kills in which most of the menhaden are filled with bleeding sores that can span

15 million fish sometimes and can stretch for weeks and sometimes even months in North Carolina's estuary. The old-timer fishermen have told us that those kills in our waters have only been with us since about the mid-1980's.

All we can do from there is speculate. The Albemarle-Pamlico is very poorly flushed and for the past 50 to 70 years we've been pouring many, many, many tons and tons of nutrients into this poorly-flushed system. There's some research on other harmful species, which indicates that if you shift the balance of ratios of nitrogen and phosphorous nutrients that are found in sewage and animal waste, if you just shift that balance in the environment, you can encourage some harmful species to become more toxic, and so perhaps what's happened is an inadvertent experiment here. We didn't realize we were adding a lot of nutrient loading that might have shifted *Pfiesteria*—which was always there—to act more toxic. We can't say that for sure, but that's one scenario that we'd like to examine further.

Mr. GILCHREST. Thank you. Dr. Boesch?

Mr. BOESCH. Could I just comment on a broader scale? You mentioned all these other harmful algal species as well. The report that I distributed earlier to the Subcommittee has a brief review of what we know about the ones that we have confronting us in the United States, as well as globally. To answer your question, I think the answer I would give is that, first of all, there are some types of harmful algal blooms we know have increased because of the long period of observation. We have a long period of study and observation in marine science in European waters and we know that these have increased over the years.

Examples from the U.S. situation: In Long Island estuaries, as well as in Texas, we have brown tides that we know did not have before. One area is located right next to the University of Texas Marine Laboratory where their observations for 50 years show that brown tide didn't occur before, so we know that that's a new phenomenon. We have others, for example the red tides in Florida and the Gulf of Mexico, which we've known existed and have wreaked havoc for a very long time. But, there's some concern that in the in-shore regions where we're polluting, over-enriching, changing the environment, we may be making those worse.

For *Pfiesteria*, the reason I think it's difficult to answer, as Dr. Burkholder indicated, is that we just discovered it. We don't have a clear understanding of what happened before in the Chesapeake or the Albemarle-Pamlico. Indeed, it has been long understood that there are more lesions in fish in the summer. In fact, in 1984, there was what seemed to be unusually high incidence of fish with lesions throughout many parts of the Chesapeake. This could indeed have been caused by *Pfiesteria*-like organisms. It's very difficult to unravel; there's some potential that we could look at cysts in the fossil record, and so on, but it may be a question we'll never fully answer.

Mr. GILCHREST. Thank you, Dr. Boesch. Mr. Garcia?

Mr. GARCIA. Dr. Boesch basically covered the point I was going to make, but in the ECOHAB work that we have done, the research indicates—the weight of the research and opinion is—that, yes, these broader incidents of broader algal blooms are occurring

with more frequency, with greater intensity and severity and they're lasting longer. So, that would be my answer to your question. And the question of whether or not we were just looking in the right places now, that's part of it. We have acquired more knowledge, but, again, the weight of the opinion is more frequent, more severe, and longer-lasting.

Mr. GILCHREST. Thank you. Mike, Walter, do you have any follow-up questions? I think what we'll do—we just had another vote, so we'll recess, also dismiss the panel, and then come back for the next panel.

If I could just—real quickly though, while we're running over there—is there any way, right now, to predict an estuary might have these troubles?

Ms. BURKHOLDER. That has eluded us on almost all of the harmful algal bloom species for a long time. We can tell you where they're likely to occur, but whether you get one that year depends on a lot of other factors that we still don't understand very well, like how weather interacts with some of the flow events and run-off; just those two factors can throw us off.

Mr. GILCHREST. Thank you.

Mr. WRIGHT. This is clearly an area of need for future research, as I identified earlier, and it's one for which we will most certainly need Federal resources and coordination.

Mr. GILCHREST. Thank you. Is the ECOHAB programs one of the central programs that Mr. Castle was referring to that we might want to fund? Does it represent a program that can draw from a variety of disciplines?

Mr. GARCIA. Yes, sir.

Mr. GILCHREST. How did Pfiesteria get its name?

Ms. BURKHOLDER. It was named in honor the late Lois Pfiester. She had a very interesting and unusual life. She was formerly a nun. She left the convent after several years, it's my understanding, and formed a family—was a professor at the University of Oklahoma. I came from a fresh-water background, and so I was familiar with her work. These organisms don't realize there's a boundary between fresh water and oceans; they call that an estuary and they go down it.

So, I had read the fresh-water literature, as well as marine literature, which is sometimes not done by marine folks. We in fresh water sometimes don't read marine research and vice versa, but I knew of her research, and she had found dinoflagellates in little bogs in Oklahoma with 38 different life cycle stages that transformed rapidly among all these different things. And so when I first found Pfiesteria doing these strange and bizarre things, it was through Dr. Pfiester's insights that I was able to make the leaps in understanding it that I was able to make. So these were named in honor of Dr. Pfiester.

Mr. GILCHREST. So, Dr. Burkholder, you are responsible for the name?

Ms. BURKHOLDER. Well, actually, Dr. Steidinger and I worked together on that name.

Mr. GILCHREST. Thank you very much Dr. Burkholder.

Gentlemen, thank you. We'll recess for about 15 minutes.

[Recess.]

Mr. JONES. [presiding] The Subcommittee will be in order.

We now have our next panel of witnesses: Wayne McDevitt, Secretary at the North Carolina Department of Environmental and Natural Resources; the Honorable John Griffin, Secretary of the Maryland Department of Natural Resources; the Honorable Christophe Tulou, Secretary, Delaware Department of Natural Resources and Environmental Control; and Mr. Rick Dove, the Neuse River Keeper, Neuse River Foundation; and also Mr. Dan Baden, Marine and Freshwater Biomedical Science Center.

Gentlemen, thank you very much for being with us today. I think most of us who have the privilege to be on this Committee appreciated the first panel, it was extremely informative and very helpful, and we're delighted to have you with us today. So, with that, we'll start with Dr. Dan Baden. Dr. Baden?

STATEMENT OF DANIEL BADEN, DIRECTOR, NATIONAL INSTITUTE OF ENVIRONMENTAL HEALTH SCIENCES, MARINE AND FRESHWATER BIOMEDICAL SCIENCE CENTER

Mr. BADEN. Good day. My name is Daniel Baden and I am the director of the National Institute of Environmental Health Sciences Marine and Freshwater Center at the University of Miami. I have 24 years experience in marine toxin research.

Toxic marine phytoplankton are responsible for red tides or harmful algal blooms known as HABs—you've already heard this. HABs occur in virtually all coastal areas of temperate and tropical seas and are responsible for five known types of seafood poisoning in man.

Specific HAB incidents are often geographically localized but there occurrence is sporadic. As I speak, in addition to the *Pfiesteria* and other fish-killer HABs in the mid-Atlantic region, Texas, Louisiana, and other States on the Gulf of Mexico are experiencing Florida red tide outbreaks. These red tides are notorious for tons of dead fish per day per mile of coast-line. All HABs are natural events induced or permitted by specific environmental conditions.

HABs are also implicated in mass-marine mortalities known as epizootic. In the past 20 years, red tide toxins have been implicated in the deaths of bottlenose dolphins in Hawaii; manatees in Florida; pilot whales in the North East U.S.; pelicans in California; cormorants and gannets on the east coast of the U.S.; fish along the entire Gulf of Mexico coast-line, also stretching up to the Carolinas and Maryland coastal zones.

As sentinel or indicator species in the oceans, marine animals are akin to the canaries taken into mine shafts. Their death or sickness is an indication of degradation of local environmental conditions. Questions concerning environmental parameters conducive to HAB development, maintenance, and termination, test our oceanographic knowledge base. Questions concerning our ability to detect and/or predict blooms as they develop address components of marine biotechnology, coastal zone nutrient loading, and life cycle biology. Questions concerning effects on marine animals touch on aspects of biomedical research, detection technologies, and whole animal physiology.

Federal and State programs that address each of these research questions individually are currently in place, but holistic research that addresses the interface between research areas is lacking. Thus, Departments of Commerce, Defense, Health and Human Services, and Agriculture need to coordinate with one another and develop partnership funding strategies.

Likewise, basic scientists, clinicians, oceanographers, ecologists, and taxonomists, all must develop better ways of interaction and communication essentially by developing interdisciplinary approaches to their science. In other words, these activities that are land-oriented and those that are ocean-or aquatic-oriented need to be coordinated in the coastal zone.

Over half of the U.S. population resides within 50 miles of a coast line. It is in this coastal zone that HABs occur, that marine animal deaths have been documented, and that coastal nutrients are changing. Coordinated, multi-agency funding packages have not kept pace with the interdisciplinary nature of the science.

Harmful algal blooms produce some of the most potent toxins known to man. Potencies only exceeded by the more familiar protein toxins like botulism toxin. HAB organisms are often toxic throughout their life cycle—there are, of course, exceptions like *Pfiesteria*, that appear to exhibit toxic phases. Because of their high intrinsic toxicity, exceedingly small amounts are required to induce lethality. Even smaller amounts may be accumulated and cause sublethal metabolic and/or neurotoxic abnormalities.

We need more research to completely define the consequences of exposure, to understand the toxic mechanisms at the molecular level, to design antidotes or therapies, and ultimately, to develop preventative strategies for man and animal alike. This is an interdisciplinary area that should be addressed by NIH, NSF, and DOC.

We need more research directed at HAB initiation, progression, and termination. Concurrently, it is essential that we develop testing methods and other tools that can accurately measure the number of HAB organisms at the beginning of a bloom. We currently know so little about triggering or sustaining factors that this is an area of active interest in all regions of the U.S. As many as 20 marine organisms produce HABs, and each has individual ecological requirements. Factors beneficial to one species may be detrimental or inconsequential to yet another species.

There is a need here for Federal-State partnerships for research and information sharing. There is a decided need for specialized programs for development of test kits, perhaps by partnership with the biotechnology industry. We need to develop testing protocols that can measure toxins through food-chains and within organs and tissues. Especially with the implementation of the HACCP program or seafood testing in December of 1997, there is a desperate need for bringing all testing to use in certification.

Finally, stable funding for the science in academic laboratories and at the State and Federal level is necessary so that we can produce rapid response teams to address HAB problems. It often seems that funding runs about nine months behind toxic events and universities are increasingly reluctant to provide the fiscal support to carry out rapid-response projects.

I would like to thank the Subcommittee for the invitation to address these issues.

[The prepared statement of Mr. Baden may be found at end of hearing.]

Mr. JONES. Thank you, Dr. Baden.

Now we will hear from the Honorable John Griffin.

**STATEMENT OF JOHN GRIFFIN, SECRETARY, MARYLAND
DEPARTMENT OF NATURAL RESOURCES**

Mr. GRIFFIN. Mr. Chairman, members of the Subcommittee: on behalf of my boss, Parris Glendening, the Governor of Maryland, and everyone in his administration, I'm honored and pleased to be here with you this morning to share with you some of our experiences at the State level in dealing with this complex issue. I might say by way of introduction, sorry to see that our own Congressman Wayne Gilchrest is not here, but he has been a great friend and leader on this and many other issues working with us at the State level in Congress.

Mr. JONES. Mr. Griffin, I assure you he will be by.

Mr. GRIFFIN. I also, of course, being here on Capitol Hill, want to recognize the efforts of others in our delegation, particularly Congressman Steny Hoyer and, over on the Senate-side, both of our U.S. Senators, Paul Sarbanes and Barbara Mikulski have been great to work with. In fact, we're all very grateful at our level for the very rapid and effective response, Mr. Chairman, coming from Congress and the President and the Federal agencies. I've been in State government now about 20 years and I can tell you without hesitation this has been probably the preeminent example of effective Federal-State partnership in responding to this crisis. And, all of you are to be commended for your support and your rapid response.

Actually, we have, in State government, in Maryland, I guess for better or worse the last several months, been a bit on the cutting edge of this issue. And, it has represented an unprecedented challenge for us and, at times, frankly, it seemed like something out of an H.G. Wells novel.

But, I thought what I would do briefly is trace looking back at the last several months some of the lessons that we've learned in trying to deal with this. And, the first one is the whole question of the learning curve. I think everybody that has approached this—from myself, the folks in our department, our sister agencies—everyone started off with a fair degree of skepticism, either because the problems that were being reported didn't seem to fit our mental maps, or because they seemed to stretch the public health science, or we were starting to question a little bit the motives of some of the folks that were bringing these problems to our attention. For example, did the watermen have other axes to grind?

So, each and every one of us as we became more immersed in this issue, I think, while at varying degrees, went from being somewhat skeptical to coming around and saying, "Hey, there's something serious going on here." So, to the extent that you think about this issue in the broader context nationally and around the country, suffice it to say from our experience there is always a learning curve with this kind of an issue.

The second lesson, I guess if you will, that comes to my mind in thinking about this issue over the last several months in Maryland, is the whole issue of addressing the fear of the unknown. This, obviously, because of particularly its public health implications has created a great degree of concern in our State, and among folks who come here to vacation. And, at first we were sort of faced with a paradox: if you voiced publicly legitimate scientific concern, whether it's in the environmental field or the medical science field, there you were fairly rapidly confronted with issues over wanting to cover up data or being in a state of denial even when those questions were raised in a fairly professional way. Where it led us in Maryland rather rapidly was to a posture of full and timely disclosure of information.

We, looking back on it, realized that in the face of the fear of the unknown the best way to handle that is to start to develop a level of confidence in the public that you are doing all that you can, that you're sharing information and data as openly as possible with public directly through their elected representatives and through the media.

And that, of course, leads to the other half of the paradox, and that is that when you do what you tend to be accused of overhyping the situation, but I think these kind of issues, as you all know, become—and they have in this case, certainly—a topic of great public consternation. And, even when you're on the cutting edge of this, and even when you're learning as you go along, I think, one of the lessons we've learned is: engage in full and timely disclosure of what you know. And, through that, I think, one can build a sense of relative confidence in the citizens and, therefore, tend to dissipate the sense of anxiety that they have. I'm not saying that that's a posture that isn't at times kind of sloppy, if you will, but for us, seems to have worked fairly well, I think.

An example of that that I would share with you—and I notice Congressman Gilchrest came into the hearing room and he, of course, was present for that, as he's been on this issue and many others leading from his role as a Member of Congress—we had a conference at Salisbury State University on the Eastern Shore of Maryland in early August. And we tried to bring together our colleagues from the Federal agencies, sister States; Wayne and Chris both sent folks from their Departments to our three-day summit. We had a number of folks from the scientific community there, elected officials like Congressman Gilchrest; and we had a number of constituents from the lower Eastern Shore, the affected watermen, farmers, people whose businesses rely on the tourism trade, and we engaged, I think, in a very open, honest, thorough discussion of the state of our knowledge, concerns, and areas of distrust that folks had about what we had done or not done.

And, I think looking back on that again, is an illustration of this notion of being as open as you can with the public, even if, for the short-term, that creates some problems. This is a long-term issue, and, therefore, you have to look at it in terms of building confidence and trust and understanding for the long-term.

The next issue, in terms of a lesson for us, I think, is the complexity of this issue and how it demands a high level of interagency collaboration. As you know, because this problem cuts across var-

ious functions of government—environmental, public health, economic, to name a few—it requires the agencies to sort of sacrifice a bit of their singular missions to the over-riding cause of understanding and solving the problem. And, I think in general, we have been able to do that in Maryland, not only among the Governor's agencies, but, as I mentioned earlier, with active participation from our Federal counterparts.

Two other points I want to emphasize in terms of this collaboration: one is the importance of science and the importance of having management agencies linked up with their scientific counterparts. Don Boesch—Dr. Boesch—mentioned in his testimony, I noticed, a reference to the fact that I had asked him to set up a scientific brain trust, if you will, to guide us in our deliberations as management agencies. Looking back on that, again, as a lesson that, I think, was a fortuitous action that we took and Don's committee has important scientists from up and down the eastern seaboard, including Dr. Burkholder and her colleague, Dr. Stidenget, and we will continue to use them as a forum to which to deliberate some of the many imponderables that confront us in terms of taking management actions when the science is either in debate or not clear.

And, of course, another example of the intergovernmental effort here was another summit that was held here last month called by Governor Glendening, my boss, with active participation from governors in surrounding States, and the EPA Administrator, Carol Browner, and a number of folks from Federal agencies, some of whom are here today testifying. That was another, I think, stellar example of the degree to which governments are kind of putting aside, more so than we typically do, prerogatives and turf and everything else, and just looking at the problem and trying to work together to solve it.

Another lesson, of course, as I reflect back on the last several months has been the importance of leadership: people stepping forward. Three come to mind: first, I assume you'll understand that I want to mention my boss, Governor Glendening; secondly JoAnn Burkholder who you heard from earlier; and lastly, Jack Howard—I don't know if Jack's going to make it today—and all the watermen down in the shell town area in the southern Eastern Shore. Each in their own way broke with convention, took risks, and did so many times in the face of a lot of peer pressure to the contrary. So, in Maryland, as Dr. Burkholder has said, we've been fortunate that our governor has been willing to become personally involved in understanding these issues, taking political risks to try to ensure the well-being of our citizens and our environment, stay the course, and make hard decisions in the face of many imponderables.

And I would like to emphasize that point and recall, as many of you know, my own personal experience in State government going back to 1985, we had declining rockfish or striped bass populations up and down the Atlantic seaboard, and we made a decision at that time in the face of uncertain scientific predictions and banned the harvesting of rockfish. And I guess that taught us a lesson that I would apply to this particular issue and that is: if you wait until all the science is in and confirmed, you may have waited too long.

And, so, that isn't to say that continuing to push the envelope in terms of advances in scientific understanding is not very important; it is, but there are going to be at times a long the way when, at the government level, decisions are going to have to be made which are not irrevocable, but are going to have to be made, and in retrospect, of course, that's what leadership is all about.

The final couple of lessons I would share with you: one is, what this issue has really, I think, brought forward for us in Maryland, is the important link between economic well-being and environmental well-being. And, if nothing else has done it heretofore, this issue has focused everyone's understanding in Maryland, I think, on the very important fact that you have to have in order to have a healthy economy, you have to have a healthy environment and they are so linked with one another. And, the impacts of this issue in Maryland, not only on the immediate economies of the fishing industry, both recreational and commercial and farmers, and the seafood industry, and tourism interest is obvious, but there are many secondary impacts that we're experiencing right now.

Finally, the last lesson, I guess, is that I think this has shown us that we clearly—you know in Maryland we've been at the effort with our sister States and the Federal Government of restoring the Chesapeake Bay. We've been at it now for about 15 years, most people feel that it's one of the several handful model efforts around the country, indeed around the world. And, so, on the one hand, you sit here when things like Pfiesteria outbreaks happen in your own State and wonder, well, gee after all this effort and we're still having these problems. But, I guess, what it has led us to think more and more about is the need to look more broadly—more holistically, if you will—at environmental complexes as were mentioned earlier. And, in terms of sources of nutrient input, start to do for nonpoint sources what we have done collaboratively for point sources during the first 25 years of the Clean Water Act.

So, I'll conclude, Mr. Chairman, and Members. Thank you for your time, and I'll be happy to answer any questions.

[The prepared statement of Mr. Griffin may be found at end of hearing.]

Mr. GILCHREST. [presiding] Gentlemen, thank you very much. I know it has been a bumpy road here for the past six months, but I think you have stayed the course and done the right thing.

We will recognize the gentleman from North Carolina to recognize his witness. Walter?

Mr. JONES. Thank you, Mr. Chairman. I am pleased to welcome the Honorable Wayne McDevitt, Secretary of North Carolina Department of Environmental and Natural Resources. And what makes this very special is Wayne and I have been friends a long, long time; and even more so than that is that he has been in this position for 70 days. And, during that 70 days, he had to deal with the North Carolina legislature as they were closing down shop in late August; and then, the people that I know that know Wayne have great respect for him, as I do, and we know that he is going to do an excellent job for the citizens of our State, not only with this issue, but other issues. Also, I would like to extend to his staff my respect and welcome to Washington, DC.

Thank you, Mr. Chairman.

Mr. GILCHREST. Mr. McDevitt?

STATEMENT OF WAYNE McDEVITT, SECRETARY, NORTH CAROLINA DEPARTMENT OF ENVIRONMENTAL AND NATURAL RESOURCES

Mr. McDEVITT. Thank you, Mr. Chairman, and also thank you to North Carolina's good friend, Congressman Jones, who not only does a tremendous job for his district there in eastern North Carolina, but for all of North Carolina. And, it's quite frankly an honor for me to be in a room that I see a former Congressman Jones portrait on the wall back here, and again, thank you for allowing us to be here.

On behalf of the Governor, I do want to thank the Committee for giving us this opportunity to testify. We have submitted a statement earlier, along with other comments, and I have technical staff with me today to assist as we continue the dialogue.

Pfiesteria was first identified in North Carolina, and North Carolina intends to be a major player in solving this problem. Much of the early work on Pfiesteria was funded through a cooperative Federal-State partnership, including several of Dr. Burkholder's early research efforts.

Pfiesteria is a serious problem and we all agree on that. There seems to be more that we don't know than that we do know about Pfiesteria. We must learn more about this organism and we'll continue to work with our Federal and regional partners to do so. But, we must look at the bigger issue: protecting and restoring our water quality. Pfiesteria is the symptom of a greater problem. We all know, and Dr. Burkholder has told us and others have told us, that significant nutrient reduction is critical if we're going to restore our rivers.

We're pleased to join in this regional approach to a common problem. Many of our States—many of the States represented here today—have large estuaries with slow-moving water, strong agricultural economies, and growth in populations, and changes in land use. The potential impacts of that growth are obvious and the need to address them is just as obvious.

Your Committee has played a major role in setting policy with respect to fisheries management, research, and the protection of coastal and marine environments. Your role in the reauthorization of the Magnuson Act, particularly as it relates to habitat protection, is vital. North Carolina has the largest estuarine system of any single State on the Atlantic coast: 2.3 million acres. Species need estuaries to complete their life cycle: spawning, nursery areas, feeding areas, and migration routes. This is why water quality protection and restoration efforts are so critically important. Fish from North Carolina estuaries and coastal rivers migrate throughout the Atlantic coast and support significant commercial and recreational fisheries along the Atlantic seaboard.

Recreational and commercial fishing in North Carolina contributes \$1 billion annually to our State's economy. Providing viable fisheries and protecting habitats are high priorities. We recently passed, in North Carolina, the North Carolina Fisheries Reform Act that will tie together our water quality, coastal management,

and fisheries protection efforts through habitat protection plans in a way that has never been done before.

Dr. Burkholder has said on a number of occasions that *Pfiesteria* is a cause for concern and not alarm. We need to work together to inform and educate the people in our respective States about the precautions they need to take to protect health while making sure our fishing and crabbing industries remain viable.

In North Carolina we've witnessed fish kills, algal blooms, and degradation of some of our waterways and estuaries due to excess nutrients. We've acted to combat our nutrient problems and we've made some meaningful progress. We need to do more. We need to do much more. But I would like to highlight for a moment some of the steps we have taken.

The Governor and the State lawmakers just concluded the most important legislative session for the environment in our history. We passed fisheries reform legislation. We're strengthening our strategy to reduce nutrients in our troubled Neuse River. We established the Clean Water Management Trust Fund which provides \$50 million annually to water quality protection initiatives. We established a wetlands restoration program. We're toughening our enforcement policies and strengthening our sedimentation and control programs. We established a rapid response team to investigate fish kills, and expanded our coastal recreational water quality testing program to protect public health. We toughened siting, permitting, and operating requirements for livestock operations and strengthened our agricultural cost-share program. We've created a scientific advisory committee, established a medical team, a hotline for citizens to call. We stepped up environmental education.

Most important, Governor Hunt signed the Clean Water Responsibility Act which puts a two-year moratorium on hog farms in the State, reduces nutrient limits for waste-water dischargers and nonpoint sources, and includes provisions for improved land use managements. North Carolina has major financial investment in funding important research programs and initiatives. Over the past two years, we've approved over \$147 million to support these efforts.

We've taken some very important steps, but we must do more. We must do much more. We've met with our North Carolina Congressional delegation and with the governors from five States, and we all stand ready to join as full partners on this issue. We've talked with them about our needs. In particular, we've emphasized the Governor's commitment to establishing a Center for Applied Aquatic Ecology at North Carolina State University where Dr. Burkholder does her research. Congressman Jones has introduced legislation to authorize funding for that center, and I would like to point out that the entire North Carolina delegation supports that, and we urge favorable action as quickly as possible.

In North Carolina we must reduce nutrients, including pollution from atmospheric deposition. We must fund additional research; we must identify additional funds for more than \$12 billion in waste water treatment needs in our State; and we must collect data and conduct research to develop fishery management plans. In order to do all of these things and others, we must have strong legislation, clear regulations, tough enforcement, good information, funding for

research, and public support. We welcome the assistance of this Committee, and our Federal partners. We look forward to working with all the stake-holders, including farmers and local governments; citizens; environmental groups, such as the Neuse River Foundation—Rick Dove, the Neuse River Keeper—and all others in cleaning up our waters.

Once again, we're pleased to participate in this regional approach. We're ready to join whatever efforts are necessary to coordinate, and communicate, and understand this better. Thank you.

[The prepared statement of Wayne McDevitt may be found at end of hearing.]

Mr. GILCHREST. Thank you, Mr. McDevitt.

I now will yield to the gentleman from Delaware, Mr. Castle, to introduce the next witness.

Mr. CASTLE. Thank you, Mr. Chairman, and it is a pleasure—an honor really—to introduce Delaware's Secretary of Natural Resources and Environmental Control—I think he has the longest name of anybody up there—Christophe Tulou, who is no stranger to these rooms, I might add. He worked with now Congressman, or Governor Carper—I get confused myself—Governor Carper as his legislative director, and helped develop legislation on sound coastal management involving the National Flood Insurance Program, and the National Marine Mammal Health and Stranded Response Program. He receives very high marks for continuing the outstanding policies of environment in Delaware by the previous administration and really responding well to the Pfiesteria issue. And we in Delaware, are very appreciative of all those things and we're delighted he was able to be here today. Christophe Tulou.

STATEMENT OF CHRISTOPHE A. G. TULOU, SECRETARY, DELAWARE DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL

Mr. TULOU. Thank you, Congressman Castle. I appreciate very much the Committee's invitation to be with you today, and Governor Carper does send his best wishes to his friends and former colleagues. He certainly has fond memories of spending many hours in this room as a member of the now-defunct Committee on Merchant Marine and Fisheries.

At any rate, Delaware has a very, very strong interest in this issue. We've had our experience with Pfiesteria in the past, as Congressman Castle mentioned earlier in the hearing, going back as far as 1987—and for all we know, maybe even before that. And, we have also found Pfiesteria-like organisms in our waters this summer. So we have an active interest and great concern for what's happening there.

You will see in my written statement a lot of what's going on in Delaware and reference to a number of things that we are doing to try to address not only the Pfiesteria problem, but what we think are the root causes of that problem; and I will refer that to the members of the Subcommittee for their perusal.

What I would like to do is just focus on what we perceive as the most fundamental needs, and they aren't terribly complex, and there aren't too many of them. But, certainly, first and foremost,

in picking up on some comments that have already been made at the hearing so far today, is the need for our research efforts to be coordinated. We can't stress that enough. The State of Delaware, and certainly the Department of Natural Resources and Environmental Control, is not going to assume the primary research responsibilities for determining what's going on with *Pfiesteria*. I don't think that's an appropriate role. But what we do need is some good information, some good facts, and good science to rely on as we go to those portions of our community that are going to be responsible to help us address those problems. And certainly, the more particular research needs are defining even better what factors are responsible for the proliferation, the toxicity, and also the human health effects associated with *Pfiesteria*.

Dr. Burkholder and her researchers and colleagues have certainly strongly indicated that nutrients are implicated. But they have also mentioned that the nutrient requirements of the organism are extremely complex, and I think we certainly need to pin that down better so that we can better direct the effort that we're going to need to exert to make sure that the basic problem is taken care of. And, I think that's the important point here, really. *Pfiesteria* is just one of many symptoms of a much larger problem that we're experiencing in our coastal waters. It's not a mystery to us that we need to be addressing aggressively nonpoint source pollution as well as remaining point sources, for that matter, recognizing that the efforts that we have made to date are obviously not getting the job done.

We have a potential *Pfiesteria* problem in Delaware. We've wrestled with it in the past. We've got over-nitrification which is leading to a tremendous explosion of algae growth in our inland bays in Delaware creating large expanses of anoxic water—no oxygen—and that's just as poisonous as any toxin that *Pfiesteria* can create in terms of eliminating large amounts—and the large diversity—of living resources that we have in those waters.

This is a critical problem, and I would say for a subcommittee that's looking for some advice on where we need assistance the most, it's not with the short-term issue alone: the long-term need to address those nonpoint sources of pollution is critical. Support for State nonpoint source pollution programs, watershed programs, and particularly, the total maximum daily load obligations that the variety of States are wrestling with right now, which is a mandate under the Clean Water Act but has for many years been woefully under-supported, is probably one of the best areas of resource allocation that Congress and the States can work together on.

So, with that statement, I'll be happy to answer any questions that you may have when the panel is finished.

[The prepared statement of Mr. Tulou may be found at end of hearing.]

Mr. GILCHREST. Thank you very much, Mr. Tulou. I'll recognize Mr. Jones once more for his next witness.

Mr. JONES. Thank you, Mr. Chairman, I'll be very brief.

I do want to recognize and welcome Mr. Rick Dove. For so long, Mr. Dove has been the voice in the wilderness as it's related to the pollution of the Neuse River down in my district. And finally, I know that he is delighted to see this day come about, and the many

efforts that you've made—and through the past years he has had many people in eastern North Carolina, as well as the governor of the State, and people throughout the State of North Carolina to join his concern to help us try to find a solution to the problem.

So, with that, I welcome you, Rick Dove, to the Committee.

STATEMENT OF RICK DOVE, NEUSE RIVER KEEPER, NEUSE RIVER FOUNDATION

Mr. DOVE. Thank you, Congressman Jones, Mr. Chairman.

For the past 20 years, I have lived on the shores of the Neuse River, certainly one of North Carolina's most beautiful and important resources. It's important to the health of the citizens, it's important to the economy of the State.

In those more than 20 years, I have watched as this resource has been slowly wasted away. Between 1975 and 1990, the degradation of the Neuse River was slow but steady. But then beginning in 1990, there was an acceleration of pollution into the river, and as a result of that, the affects that we saw, including the massive growth of *Pfiesteria* in our waters, got to a point that we had never seen before.

As a river keeper for the Neuse River, I am one of more than 20 licensed river keepers in the country. I am a full-time paid citizen representative on the Neuse River. My sponsor is the Neuse River Foundation, a nonprofit organization in Nutter, North Carolina. So, when I talk to you today about the river, what I want you all to know is that I'm giving you the citizen's perspective of what's happening—what's happened—on the Neuse and what is happening.

As I said earlier, the Neuse is a beautiful river. We've had fish kills for a long time on the Neuse River. I've talked to the old-timers extensively. I spend a lot of time on the water, flying over the top of it, talking to fishermen, talking to people who've lived there—some of their families have been there for hundreds of years. And, you get a pretty clear picture of what's been going on in that river through those people—through their eyes. And we know that we've lost fish for a long period of time on the Neuse, mostly as a result of low oxygen levels which also has a pollution connection. But, we really never began to see *Pfiesteria* on the river until the mid-1980s and by the 1990s—and at that time I was a commercial fisherman, I actually gave up fishing because I could no longer stand to see the fish coming out of the river and the crabs with their sores.

So we began to see fish with lesions in large numbers. By 1991, we lost a billion fish on the Neuse River. It's hard to imagine a billion fish dead on one river. But I promise you, they were there. There were so many dead fish that they were using a bulldozer to put them into the beach in some areas. The stench from the fish was so bad that people didn't even want to go outside their houses.

Very few of us, and I don't think any of us, knew back in 1991 what was causing the fish kills. We knew it wasn't low oxygen because we were testing for oxygen and the oxygen levels were fine.

Again in 1995, we lost 10 million fish. Now, the Neuse River Foundation is the one—it's members were the ones—that conducted that survey, and we did it as scientifically as we could. We

only counted dead and dying fish on the Neuse for 10 of the 100 days they were dying in 1995. But clearly, that fish kill was not as bad as the one in 1991.

We've also had fish kills and fish with lesions on all the other years. Some years are better than others. In 1997, this year, we have documented the loss of over 390,000 menhaden fish with sores, very similar to the picture that I have given to each of you.

We also noted, beginning back in 1995, that we've had a number of our citizens—our fishermen, our bridge workers, and others who were working on the water—reporting illnesses related to *Pfiesteria*. As a matter of fact, in 1995, the State health director called me personally and asked me to send in the names of all the people that went out on the boat, from the media and others who would go out on the river, to give them their names so that they could ask them whether or not they were suffering any problems. Not surprisingly to me, 47 percent of the people that were interviewed said they had problems that were related to *Pfiesteria*—or at least their problems could be related to *Pfiesteria*. Yet in all that time, including to today, the State health director in North Carolina has refused to acknowledge one existing case of *Pfiesteria* in humans in North Carolina. We know it affects the fish, but does it affect people? There's no doubt in the minds of the people who live on the lower Neuse, but we still are searching for the truth in North Carolina when Maryland has been able to find it in a matter of months.

Now there's been a number of things that have happened—good things. We feel very fortunate that we have a new secretary for the environment in North Carolina, Secretary McDevitt. He has done a lot of good work already in the few days that he has been doing this job. He has come to grips with the truth of what's been happening down on the lower Neuse and I'm so encouraged by the fact that he is our man in North Carolina and we're going to be able to work together. But, we've got a long way to go. He has no control over health in North Carolina; that's under a different secretary. We must come to grips with the health problems we have in North Carolina as a result of *Pfiesteria* and other pollution sources in the river.

The other thing that we need to do is we need to get busy about fixing the real problem, which is not *Pfiesteria*. *Pfiesteria*, as you've heard from so many of the other panel members, is only a symptom of pollution. Pollution is the real problem. It is important that you allocate money for research. Please don't not do that. You must do that. But spend that money wisely.

We've got Dr. Burkholder in North Carolina. This bill that Congressman Jones has introduced to fund a research center in North Carolina—certainly we need a research center in North Carolina. North Carolina—Maryland today, is seven years behind where North Carolina is. We've had these problems in North Carolina for seven years now. So we need that research. But we really need—and we need it on North Carolina waters. But we really need, more than anything else, we need to get pollution reduced in our bodies of water. That's the real answer. We may even be able to solve the *Pfiesteria* problem without ever understanding it if we simply reduce the pollution levels.

I know my time is up and I want to end just with a couple of solutions that have already been mentioned by the other panel members. We have one great law in this great country of ours, it's called the Clean Water Act. It has really helped save our rivers from very serious degradation over the 20 years. But it has been very poorly enforced in certain key areas. The total maximum daily load provision of that law, section 303(d), mandates that States, when they have waters not meeting their designated use, find out what is the pollution—what is the pollutant—that's causing the problem, and then to establish a total maximum daily load for that pollutant so that the river is restored, mandatorily restored, to its designated uses. States across this country, including North Carolina, have not followed the law. They simply have not followed it and the EPA has not enforced it.

We are currently—the Neuse River Foundation has currently got a suit pending against the EPA on that very issue. We must enforce it. That law empowers citizens like me to do things to protect the water. The citizens of this country own the water.

The other thing is that the law needs to be broadened and strengthened to include nonpoint sources. It's hard to believe, but it's true, in North Carolina we have 10 million hogs. We are the number two producer of hogs, the number one producers of turkeys, and the number two producer of chickens. Those 10 million hogs are producing the equivalent feces and urine of all the people in the States of New York and California combined. It's stored in open pits. It's not disinfected before it's thrown on fields. Those fields are all ditched to carry runoff to streams, creeks, and rivers. What's really frightening is that 80 to 90 percent of all the nitrogen produced by animals: chickens, turkeys, and hogs—I don't know about chickens and turkeys, it may be a little less percentage—but on hogs, according to USDA, 80 percent of all the nitrogen produced by those animals is discharged to the environment as ammonia gas—that's another form of nitrogen. It travels about 62 miles and 100 percent of it is redeposited on their church yards, their school yards, our rivers, and our forests.

Rivers do not have an assimilative capacity. They do not. One of the mistakes we have made in this great country of ours is that we have assumed that they do. That we can put pollutants into water, into rivers and streams, without degradation. We've done that with pipes to the river called point sources, and agricultural runoff that we've allowed to get into the river. If we want to save ourselves from Pfiesteria and other micro-organisms like it, we must realize that rivers do not have an assimilative capacity. Nature sets up a balance for them and everything we do to them upsets that balance.

Thank you, sir.

[The prepared statement of Mr. Dove may be found at end of hearing.]

Mr. GILCHREST. Thank you, Mr. Dove. Your testimony has been very compelling. I'm going to yield first to Mr. Jones, because he has to leave for another appointment. So Walter, you're recognized.

Mr. JONES. Thank you, Mr. Chairman. I have a couple of questions of the secretary of North Carolina as well as Mr. Dove.

Mr. Secretary, would you please tell the panel how much money the State of North Carolina has invested in the areas of trying to deal with the water problems, whether it be Pfiesteria or other problems that we might have had in the seven years since the State has become aware of it?

Mr. MCDEVITT. I'm not sure I have those numbers for seven years. I can tell you that during the last two years, that number is in the range of \$147 million of State money. That includes a Clean Water Management Trust Fund. We put about 6½ percent of remaining funds after the budget is complete into a fund and that's anywhere from \$40 to \$50, \$55 million a year. And, in addition to that, we just, of course, passed the Clean Water Responsibility Act. We've significantly increased our ag share program, working with the farmers on BMPs and so forth; so, \$147 million if you total that.

Mr. JONES. Let me—in a statement that Mr. Dove made and I want the panel to understand—the Committee, excuse me—that farming is important in North Carolina. It is a way of life, it is a way of people earning a living. And I think that the State of North Carolina, Mr. Secretary, I'd like you to speak to this, has tried to find that balance between the hog industry, as far as responsibilities shared, in an effort to try to ensure that we are protecting our waters.

Mr. MCDEVITT. Yes, the thing that we certainly know is that we have a nutrient problem in the lower Neuse. I mean, all of us know that, and we have a serious problem there, and there's enough—the causes are both point source and non-point source. They—it's everything, Congressman, from the agricultural industry to municipalities, industry, homeowners, developers, golf courses, sedimentation control problems, urban runoff, and all of us share in that problem, and all of us share in the responsibility of fixing that problem. In the—over the past few years, we—I don't know how deep the debt is, but in terms of a natural trust, in terms of the natural trust that we hold, and we must pass on, we've borrowed a little too deep into that trust, and we've got to pay back, and we've got to pay that back now, and we must understand that, and that goes across the board, Congressman. I think all of us share in that.

We in North Carolina, in this past legislative session, we established a moratorium on expansion or new hog farms, and we believe that during that moratorium, we can establish, hopefully, more clearly—we're doing research relative to odor; relative to nutrient load, and during that moratorium—and that's not enough; we've got to do more—but during that moratorium, we hope to use that time to do the research necessary to clearly establish where some of the responsibilities lie. We know that it's all of us.

Mr. JONES. Thank you. Mr. Chairman, if I could ask Mr. Dove just a couple of questions? I'd like to start with this leg with the sore on it. If you could tell the panel—the Committee a little bit about this individual, and if you would—as you talked to me a little bit earlier—about the concern that you have that there are many people in the State that possibly are sick because of this problem, and, obviously, you made in your statement a concern that maybe the State—and I think that's very helpful with the Sec-

retary being here—your comments about maybe the State not doing as much as you would like to see them do, and maybe other people feel the same way. Could you speak to this just briefly?

Mr. DOVE. Yes, sir, I will, Congressman. Those sores are on the leg of a man by the name of Roy Rice. He is a clammer. He spends physical time in the water, not in a boat, over the top of it, but actually walking in the water; he gets wet a lot. He's fished in the Neuse River; he also fishes the inside water of the outerbanks. If he wears protective clothing, like a glove on one hand, he doesn't get the sores where he stays covered, but in all areas of exposure he get the sores. He's had memory loss to the point where he's not been able to find his way home in his own neighborhood. He can't—like so many fishermen and so many others, he cannot afford a doctor, so he's never been to a doctor that I know of, but he did ask the State to have somebody take a look at him, and we actually asked the State, epidemiologist, Dr. Stanley Music, and introduced this man to him personally. He's also been on national television, this individual, to have somebody take a look at him. To my knowledge, he's never been examined.

I'm not a doctor or scientist; I can't know and do not know whether these people are getting sick from *Pfiesteria* in the water, but I can tell you that my judgment is that the sores look the same; the symptoms are the same, and as I look at the experience in Maryland and what has been discovered there, what's been happening in North Carolina is echoing what has been reported out in Maryland where they have documented these illnesses. But we've never had a team of doctors; we've asked for it—there are no—to go down on the Neuse and the Tar-Pamlico and actually examine these people as they did in Maryland. We've been asking for that since 1995. There are no protocols for local doctors in Newborn, Elizabeth City; anywhere along the coast to report to the health director, to my knowledge, these illnesses that these people are reporting, so we've got a lot of work to do. I would like to point out, Congressman, that the health department in North Carolina is not under Secretary McDevitt; it's under a different secretary.

Mr. JONES. Thank you very much. Thank you, Mr. Chairman.

Mr. GILCHREST. Thank you, Walter. I yield to Mr. Castle.

Mr. CASTLE. Well, thank you, Mr. Chairman. Just listening to this whole conversation, this morning and this afternoon, it seems to me that—as I think Mr. Dove said or one of you said, at least—that *Pfiesteria* is only a symptom of pollution, and I think that's correct, and I worry about the—I guess we're dealing with the point source better than we used to, but I'd be curious as to the views of any of you, with respect to the different groups, the larger groups which may be involved in non-point source problems: the poultry industry, the agricultural industry, the golf course makers, the towns and the non-point part of what they do, the runoff from roads, whatever it may be. Are we getting cooperation? Are we moving up on that? I mean, ultimately, we may solve this problem without ever really being able to identify, truly, what the problem is if we can do better in those areas, and I know when I was governor, we kept trying to push this, and I'm sure all of your governors are as well, and I just wonder if you could give me a State update of how you feel we're doing in those areas?

Mr. TULOU. I'll take a first shot at it. There are a lot of initiatives going on in, I presume, all of the States to deal with that whole suite of problems: working with municipalities; with sediment and storm water control programs; dealing with the agricultural community through best management practices and in investments through cost share programs; a variety of manure management and dead poultry techniques, for example.

I think the biggest problems we have right now are: one, land use and the associated increase in population that's going along with it; more and more pressure being applied on the system, and I'm not sure our measures are keeping up, and I think the other thing that we need to continue to work on is our ability to measure what the effectiveness of these variety of programs is, because I can foresee a day when we are going to have to consider a course of action far beyond what we have already engaged those parties with, and we're going to need some good, solid foundation to justify those actions.

I would imagine, as John Griffin mentioned, and certainly some frustration in North Carolina too, with all this activity that has taken place through the years under the Clean Water Act to deal with point sources, and we're starting to deal in some ways with non-point sources, a great deal of frustration that we're beginning to see some problems instead of seeing the old ones go away, so there's a tremendous amount of effort that's left to be undertaken.

Mr. CASTLE. Anybody want to add to that quickly, and we can—

Mr. GRIFFIN. Yes, I would say, Congressman, our experience in Maryland—they're still pretty much in the nascent stages on addressing urban runoff. I mean, it's true, we've had more sediment and storm water control programs implemented primarily through our government since the mid-eighties, but that's really addressing redevelopment or new development. In the unchartered waters, we've really not done quite a lot, or much at all yet, as retrofitting: coming into areas that are already developed and figuring out how to deal with runoff of urban areas.

On the agricultural side, we certainly made a major effort, through our Department of Agriculture, to reach out to the farming community and enlist their support, and we spent a lot of money both in terms of staff and cost sharing. I think what this issue raises is not necessarily the good will or intentions of us to the farming community members as much as it raises issues with how effective our thinking has been about how best to control some of the runoff, some of the animal waste. And the science is changing on us. You may have heard earlier the phenomenon in scientific thinking that phosphorous was bound up in the soil particles and now that's not the thought, and that changes dramatically how you approach runoff. But in general, I think that we've come farther in terms of a foundation with the farming community interest than we have with urban Maryland, if you will, and that's an area that we need to spend a lot more time on as well.

Mr. CASTLE. But I worry a little bit that we're sort of burying our heads in the sand, and so are some of the different groups, they're all saying, "Well, don't look at us," and I doubt if any one of them is the sole factor that we have these problems be they low oxygen

problems or Pfiesteria problems or whatever, but the bottom line is that in the aggregate those problems still exist, and we have to have the courage to stand up and say we need to talk about this in a good communication sense, and this business of saying, "Well, leave them alone" is probably not healthy in the long term for their industry or for solving these problems.

Let me jump to another question, I only have a moment here. And that is, do you have any comments concerning what the Federal Government is doing or should be doing? My view is—I'm not, as I said earlier, you've probably heard from my other questions—but I'm not interested in funding a series of different research centers in different States or whatever. I'm interested in solving the problem. I'd just as soon have all of you together, talking with everybody who is knowledgeable about this, and my question is are we doing the right things at the Federal Government level? Are there other things that we should be doing, either with existing funds and programs or different funds and programs? Any thoughts along those lines? I mean, that's the one thing we can really control here.

Mr. McDEVITT. Congressman, I think, first of all, just these kinds of hearings, the kind of attention, often, in order to make the tough decisions, it requires a number of things, and sometimes—I don't know what all it requires—but sometimes, through magic, we're able to have the kind of legislative session we just had in North Carolina, but most importantly, it takes public will, and this—and these kinds of hearings, media attention, those kinds of things; having people like Rick Dove always calling on you and saying, "Do you need to do more?" That's—I must tell you, that's helpful. In my seventy-some days, he's become a friend and a colleague.

But to answer your question, certainly, we need a lot of money and research, and we must know—we've got to know what we don't know about Pfiesteria, but beyond that, some assistance with innovative ways to treat animal waste; assistance with new technologies and new ways to look at the treatment of animal waste, I think, is important. Looking at the Clean Water Act, not only in terms of reauthorizing but also looking at what we can do in terms of non-point source, I think is something in the bigger picture that we can look at.

Last—I had a role in the coordination of North Carolina's response to following the Fran, Hurricane Fran, in North Carolina. There was a tremendous loss to North Carolina, and as I think about that response and how we very quickly went into a mode in North Carolina and very quickly knew who our Federal partners were and how we could enter a system that's sometimes confusing and complex, and get things done in a very short period of time, perhaps, we ought to look at that model, and that model of partnership and, perhaps—I don't want to say that level of emergency, but, certainly, a level of urgency. And, so I think just—and I feel that now. We know more now than we've known—you know, we know more today than knew yesterday, but I do believe that those are just some thoughts I would have relative to that.

Mr. TULOU. Just very quickly, if I could, add to that. I think that through all the testimony that I've heard during the course of this hearing, we already have ample evidence that people believe that

a coordinated approach is important, and we also have a lot of evidence that a coordinated approach has already been taken, and I think that, for example, the Centers for Disease Control, EPA, the National Marine Fishery Service, The Fish and Wildlife Service, and congressional action; some of the initiatives that you and Congressman Gilchrest have been engaged in terms of finding resources have always been geared towards a regional approach and some coordination in terms of coming to a resolution of the problem, and I think that's to be commended. I don't see a real problem there, but I think that the coordination is more important than the money, and I don't know how best to make sure that's happening, but certainly the oversight of this Subcommittee would be very helpful to make sure that EPA's talking to the Department of Commerce and NOAA and the Centers for Disease Control, and if we can continue to do that, I suspect at the State level, we'll doing our share of insisting on that as well. We're already coordinating and talking, and I think that that will continue.

Mr. CASTLE. Well, let me just close, if I may, Mr. Chairman, by just saying that I agree with what you've stated. I think you probably have more depth of knowledge than I do about the programs. In fact, Wayne and I were talking a little bit, walking over to the votes, that it's fine to pass amendments and do this and do that and get money here and there, but it's not a coordinated approach. We aren't solving the problem the way we should, and I think it's very important that we continue that communication, and I would like to thank Rick Dove for his involvement and for being here. We have some Rick Doves in Delaware too, and sometimes I'm happy to hear from them, and sometimes I say, "Boy, they're pushing me a little further than I'm ready for."

[Laughter.]

Mr. CASTLE. But it's people like you who make a difference.

Mr. DOVE. Can I add just one quick comment in response to your question?

Mr. CASTLE. Certainly.

Mr. DOVE. One of the problems the State's have is that down in the trenches—now, you're talking about this coordinated effort and all; that's great—but down in the trenches is where it happens and doesn't happen, and when you talk about cleaning up pollution, what's tough for the States is that the guy's with the biggest bucks—well, they all point to the other guy. When you go to them and say, "You're doing this, and you need to fix it"—everybody wants a clean river, but they want the other guy to fix it, and then they begin to employ the lobbyists and everything else so they don't have to do their fair share.

On the Federal level, if you strengthen the Federal Clean Water Act, you will make it easy for the Wayne McDevitts of this world, the governors across the United States, to actually get this job done. I think that's why it's so important that you do that. We need to stop this finger pointing. Congressman Jones was right, farmers are important to North Carolina; nobody wants to see them go away, but we want to see hog lagoons go away; we want to see open storage of chicken and turkey waste go away, and we want to see waste water treatment plants reduce—take their pipes out

of the river wherever possible, and then certainly reduce their nitrogen discharge to the technology available.

Mr. CASTLE. Thank you very much.

Mr. GILCHREST. Thank you, Mike. I'm going to ask a few questions, and if you have a few more in the next five minute cycle, the panel doesn't look like they want to leave anytime soon, so we'll enjoy the Nation's Capitol.

Mr. Dove, I'd like to follow up on that one point, your comments earlier and your comments now about strengthening the Food and Water Act and giving the governors the Federal regulations that they need to push some of these non-point source pollution concerns a little harder. If we could put that aside, just for a second, using the experience that we've had here, whether it's Maryland, Delaware, North Carolina, or wherever, could you sort of summarize to us the collective responsibility of those in a position to deal with non-point source pollution, but chose not to deal with non-point source pollution, whether it's out or not—I'm talking about the planning commissioner of every county, the county executive, the county administrator, the local delegates to the general assembly, the governor of the State, their department of the environment, their department of fish and game, or whatever? Do you have some sense of the collective responsibility of those people regardless of the Clean Water Act and the Federal role, who, out of a misunderstanding or out of direct misuse of their power, chose not to deal with this non-point source pollution?

Mr. DOVE. Mr. Chairman, I can. I think it all comes down to dollars. The real client involved is the water; fixing the water. Everybody should be taking care of that client which is the water, but, instead, others creep in as the client: the farmers, the industrial guys, the developers. They all become the clients, and all of sudden we begin to take care of them and take care of their needs to the detriment of the real client which is the water, and Secretary McDevitt and I had conversations about that.

When a crisis comes up on the lower Neuse, there's great economic suffrage going on on the Neuse River; beautiful river; it's a treasure. We ought to be doing so well along the Neuse River because of the beauty of this river, and, instead, we're losing business; fisherman are going out of business, can't make a living; same experience as in Maryland, but what happens when that takes place is that local county governments begin to respond taking pipes out of the river as they have at Newborn; developing plans to begin to take care of the river, but while that happens on the local level, it's almost impossible to move it up stream to take it to the small towns that go further and further upstream. So, it's, again, we're serving the wrong client. A lot of times we're taking care of waste water treatment plants, allowing cities to grow—you know that old statement, "We got to keep growing and growing and growing." Well,——

Mr. GILCHREST. It's almost like an oxymoron.

Mr. DOVE. It is.

Mr. GILCHREST. I guess what you're saying then is what we're talking about, the collaboration between Federal, State, and local agencies and universities, in order to understand the nature of Pfiesteria, that same kind of collaboration needs to be done if we're

looking at Federal laws as far as the environmental solutions are concerned and environmental regulations.

I'd like to just take this thought one step further, and ask the three secretaries, basically—I'm going to ask this question, because, on the one hand, I don't know how big the Neuse River is. I don't know how to compare it to the Pocomoke Sound or the Pocomoke River or James Creek or the Chesapeake Bay, but one thing is very striking and that's a billion fish in one year, I guess.

Mr. DOVE. In a matter of a couple of months.

Mr. GILCHREST. In a matter of couple months. I'm looking at a billion fish in one area and maybe—you made a comment about 300,000 at another time, and I'm looking at 50,000, maybe, in Maryland, and, maybe, 50,000 in Delaware a few years ago. What role should secretary of the Department of Natural Resources—what is their responsibility to responding to a crisis like this? Do they—are they subject to—are you subject to political pressure? Everybody's subject to political pressure, but how far should a secretary of the Department of Natural Resources go to respond to a crisis? Is there a limit to the number of people they should talk to? Should they take in the political considerations, economic considerations, hysterical considerations? What's the specific role of the secretary in responding in a timely fashion, comprehensive fashion, to an incident in the State, whether it's 50,000 fish or a billion fish?

You've got 15 seconds.

Mr. MCDEVITT. Fifteen seconds. First of all, I would say that I believe that the public should have confidence in their public officials. They should be confident that their public officials, whether that's the secretary of the department—it should not be about me, the secretary, or about the governor, it ought to be about doing the right thing. It ought to be about having a systemic approach and partnership in place that allows us to do the right thing and has the protocol so that we do the right thing at the right moment. But it's also about leadership; stepping forward and doing the right thing and providing that leadership. I believe that that's the case. I know that we must depend on good science to make good decisions. I'm not a scientist, but I believe, as my friend from Maryland believes, that good public policy sometimes just must be ahead of absolute science. We've got to step out there, and whatever risk that is—we must also consider, though, making sure that we're not creating—we've got to be responsible that we're not creating hysteria; that we're not creating undue pressures on certain economies. I know we've read—and I know it's anecdotal—but we've read about the numbers of and the impact of this on some of our markets, and we must be responsible as we go through these urgent matters.

The other thing I would say is that gaining consensus on these kinds of things, particularly, nutrient controls, whether it's point source or non-point source, as Rick said, gaining consensus on that is very difficult, and—very quickly—there are lots of parties at the table, and there are a lot of decision makers in that process, but gaining that consensus is very difficult. It's also incumbent upon us, as leaders, to get out there and provide the leadership to gain that consensus. We feel like that in North Carolina, we're beginning to get the kind of tools necessary to do the job. We've got to

do a lot more, but we're beginning to get the kind of tools to begin to do the job and do it well and——

Mr. GILCHREST. Can I ask, Mr. McDevitt—and I don't want to pick on North Carolina; I spent two wonderful years in North Carolina at Camp LeJune, one of the finest places——

[Laughter.]

Mr. GILCHREST. [continuing] one of the most beautiful places on the face of the earth.

Mr. McDEVITT. They have a great environmental program there, too, I might add.

Mr. GILCHREST. Got to keep those copperheads alive.

If I could just ask—my time has expired, and—Mike, do you have any more questions? All right, I'm going to go to Mike after this quick question. Any of the other secretaries can answer this.

One of—we're talking about sewage treatment plants, runoff from streets, runoff from lawns, air deposition, ag runoff, a whole range of things, and some dramatic changes, probably, have to occur in a relatively short period of time, so have to know how to transition ourselves into those fairly dramatic changes. One of the dramatic changes, it seems to me—and Ken Staver's here from the University of Maryland and the Wye Institute who has done some very fine research on agriculture and nutrients, and for about 10 years—Ken can correct me for any mistakes I make while I'm up here—for about 10 years, it's been fairly evident that phosphorous becomes dissolved; moves along the surface with rain water, and so that there's a number of areas, for example, on the Eastern shore where soil has exceeded its capacity to process any more of that phosphorous, so it moves into the water.

Mr. McDevitt, you mentioned that there are going to have to be some changes in agricultural practices to reduce this nutrient runoff. Nitrogen is one of those things that we, in Maryland, have been pretty aggressive with, but now we're going to have to transition into understanding how we can control phosphorous which is a little bit more complex. Is North Carolina, in your ag program, going to consider phosphorous? I think it also—one last little comment—I think this is going to be a national issue, so it's not the fact that Maryland has to deal with it or North Carolina has to deal with it or Delaware has to deal with it, it's on a fast track to becoming a national standard. Do you have any comment on phosphorous as far as the hog farms are concerned?

Mr. McDEVITT. Let me ask Dr. Thorpe to—if he would—to respond to that particular question of phosphorous.

Mr. THORPE. Well, we would certainly agree that we shouldn't just focus all of our attention on nitrogen—excuse me while I try to get a little comfortable here.

[Laughter.]

Mr. THORPE. We recognized in North Carolina in the mid-eighties that phosphorous was a problem in the Neuse River. We put restrictions on waste water treatment plants at that time, and in 1987 there was a ban put in place by the general assembly on phosphate detergents that, overall, reduced the discharge of phosphorous from waste water treatment plants by about 50 percent. As far as agricultural operations are concerned, we have focused primarily on nitrogen, because nitrogen is very soluble, and it's

very mobile in the environment, and that's been our focus so far in the rules that we've been trying to get put into place in the Neuse River basin.

Mr. GILCHREST. It's a difficult question, because we don't have the complete answer to it yet, either, and we've focused on nitrogen. Phosphorous, however, it seems to me, that this is a dramatic change that we have to transition into, and I'm not going to say the farmers are going to control phosphorous by January or even next year, because we have large piles of manure that nobody wants. And where does it go? And it adds a great deal of confusion to the farming community, and talk about wanting to develop trust between ourselves and the public, we don't want to throw a 98-mile an hour curve ball at anybody at this point, but it just seems to me that the phosphorous issue is an issue that every single State in the country, especially those areas that have large concentrated feed operations, are going to have to deal aggressively with it, because if we're going to enforce all the provisions which have been here earlier of the Clean Water Act, then the total allowable daily load, if that's enforced, then we have to have an answer and a solution to the phosphorous problem.

But I sort of just raise that as an issue that, certainly, is up—the level of that issue is here, now, in Washington, and that's being discussed aggressively, but if the States don't begin the process of coming up with solutions to what you're going to deal with the animal—how you're going to deal with the animal waste; how you're going to redistribute it; whether you incinerate it; whether you feed something to the hogs and chickens that doesn't produce as much phosphorous; all of these issues are—you know, the public is looking to us for answers.

Mr. THORPE. If I could, I would like to mention that part of what we have proposed to do in the Neuse River basin is to put into place some mandatory controls on agricultural operations that would require them to go through nutrient management training, and to put into place nutrient management plans and waste management plans that do require the farmers and the operators of agricultural intensive livestock operations to control both nitrogen and phosphorous through those mechanisms.

Mr. GILCHREST. I'm going to thank you very much. We'll try to make sure there's a chair there next time you answer a question.
[Laughter.]

Mr. GILCHREST. I'm going to yield, now, to the gentleman from Delaware.

Mr. CASTLE. Well, just briefly, and this is—maybe I should have asked this before—I think Dr. Burkholder's still here—but I was—low oxygen bubbles were mentioned, and I was wondering about the relationship—and I guess there's a relationship in that there's water, and there's, maybe, too many nutrients and that kind of thing—but is there any possible relationship between this low oxygen bubble issue and the issue of Pfiesteria outbreaks?

Mr. BADEN. Yes, let me address that, just briefly. First of all, I think we're talking about coastal pollution; somehow we got away from Pfiesteria and into more nutrient enriched areas and making the assumption that all the science is in that nutrient enrichment is, indeed, responsible for Pfiesteria, and if you look along with the

Pfiesterial blooms in these areas and in North Carolina, we're talking about other types of organisms that are also toxic: peridiniopsisoid organisms, gyrodiniums, that also cause fish kills, the Pfiesteria, of course in Maryland fish farms, and scripsiella-type organisms.

Now, all of those individual organisms have different types of nutrient requirements, and, as I made in my testimony, some are adversely affected; some are promoted by increased nutrients, and we have to be very careful, because if we—I think that reducing the nutrients is a wonderful and the Clean Water Act and all of that, but I'm not so sure that once we do that, you may just have cleaner water to see your Pfiesteria.

So, you know, we have to be a little bit careful, and at the same time, study that organism in detail to know about the nutrient requirements, and that goes directly to the Chairman's comments about phosphorous with phosphorous being limiting in most of these environments; There is enough phosphorous in all stages of the bloom, but each individual organism is different in its requirements.

Mr. DOVE. Excuse me, but, Congressman, can I answer that question that you had based upon what I've seen on the Neuse River?

Mr. CASTLE. I'd be also interested in knowing what causes the low oxygen bubbles. I mean is it—as scientifically as you can say it, too. Maybe I don't understand that.

Mr. DOVE. Yes, sir. I can give you the non-scientific explanation, but maybe it will be the easiest one to understand, because it's been explained to me so many times, is that when you have nutrients that get into the water on the low oxygen side—when you have nutrients that get into the water, they cause things to grow in the water in larger numbers than they would on ground, because water's more sensitive to nutrients. When those things grow, especially algae from the plants, they photosynthesize during the day, and produce a lot of oxygen in the water, but at night they respire, because there's no sunlight, and they suck the oxygen out of the water like a vacuum cleaner, and on the Neuse River we can see millions of fish of all sizes up in one inch of water just trying to work their gills to get through the night; get enough oxygen to make it through the night; a lot of times they don't. When the sun comes back up, the oxygen returns, because the plants begin to photosynthesize again. When you have too many nutrients, and you have too many things growing, then you upset that balance, and that causes the oxygen to be depleted.

But the answer to your question earlier, sir, from my observations on the river, there is no relationship between low oxygen levels and Pfiesteria. The reason I say that is that I have been watching this river very closely, and the Neuse River is a good area to observe Pfiesteria; it's where the largest kills have occurred. In the summertime, in the months of June and July, when the oxygen levels begin to drop, July, even into August, fish do die from oxygen losses, but they don't show sores, and you don't normally find Pfiesteria in the water samples, but then the oxygen levels return to normal in September, October, November, even into December, and that is always when we've had our largest fish kills on the

Neuse River. Now, I've heard some scientists say that, "Well, gee, when the oxygen levels get down, the fish get wounded, they get hurt, and then they're more susceptible to *Pfiesteria*," but that is not my observation of watching it out in the river, sir.

Mr. CASTLE. Well, it would sound to me—maybe Dr. Burkholder wants to comment—it would sound to me as if the—while they may be different problems, a lot of the causes are the same, if not identical, based on what I'm hearing from here.

Ms. BURKHOLDER. I think that's true. Some of the organisms that Dr. Baden referred, in fact, most of them are autotrophs, that is, they're algae, and they tend to be stimulated, in general, by nutrients to some degree. In terms of *Pfiesteria* and *Pfiesteria*-like cousins, so far the experiments we've done have indicated that they can be strongly stimulated by high nutrient enrichments especially in poorly flushed areas, but the dissolved oxygen connection, as Mr. Dove points out, is only indirectly present. *Pfiesteria*-like species, including piscivores, feed upon algae many times when fish are not available, and when there are lot of nutrients that stimulate a lot of algae, then there will be a lot of *Pfiesteria* waiting for schools of fish to come up estuary. When dissolved oxygen has been low because of all those algal blooms taking the oxygen and robbing the oxygen from the water at night so that fish can't breathe, you often find *Pfiesteria* in those areas. I think that fish that are stressed are easier targets for *Pfiesteria*, but they don't have to be stressed for *Pfiesteria* to kill them. We've lost 1.2 million fish this year on the Pamlico, on the Neuse estuaries in combination in North Carolina, during June and July, before low dissolved oxygen even came into our bottom waters.

Mr. CASTLE. Thank you. Thank you, Mr. Chairman. I appreciate the opportunity of participating today.

Mr. GILCHREST. Thank you, Mike. Dr. Baden, you're from Florida.

Mr. BADEN. Correct, University of Miami.

Mr. GILCHREST. Have you had similar—is there any—have you seen any of these similar type fish kills in the estuary along Florida? When was your first association with the incident of *Pfiesteria* in North Carolina, and how was that evaluated in your lab? Could you give us some idea as to—I asked this to, I think, Mr. Garcia, earlier on the panel—there has apparently been a regime of research over the last six months that is recognizing the existence of *Pfiesteria* or *Pfiesteria* complex without understanding, I would guess, the nature of the chemical makeup of the toxin and what exactly that does and what causes the *Pfiesteria* to go into that particular stage. So, the third question I have—if you can remember the first two, because I don't—

[Laughter.]

Mr. GILCHREST. [continuing] the third question I have, is do you have some idea as to when this research can come up, after peer reviewed, to some conclusion?

Mr. BADEN. Okay, the answer to your first question as referred to when was it first seen in Florida? The organism is present in Florida. We do not, as of yet, to my knowledge, have major fish kills that we have characteristically identified with a *Pfiesteria* or-

ganism, but we do have a very similar organism in Florida; that's the first question.

The second question referring to the *Pfiesteria* outbreaks in North Carolina, I've been associated with Dr. Burkholder and with Dr. Noga since 1991 in working on *Pfiesteria* toxins, and I—along this line, I guess I can say that in the case of toxic purifications and characterizations, one of the critical elements—well, actually there are three critical elements: they're are material, material, and material. And in that regard with a *Pfiesteria* organism we have massive cultures of this organism in order to be able to characterize the toxin, and let me explain. In the case of paralytic shellfish poisoning, back in the forties, fifties, and sixties, there was a tremendous amount of saxitoxin, the principal organism—or the principal toxin that was isolated—

Mr. GILCHREST. When was that year again?

Mr. BADEN. 1945, fifties.

Mr. GILCHREST. Where was that?

Mr. BADEN. This was—actually, it was off the coast of British Columbia. It was done by Dr. Ed Shantz and Carl Medcof, and in the case of paralytic shellfish poison, it took something on the order of 45 milligrams of toxin to get a true structure characterization. In the case of the brevetoxins, which are the Florida redetidoxins, done by Nakanichis' group at Columbia, it took 91 milligrams of brevetoxin to get enough material to get structure. In the case of *Pfiesteria* toxins, even in purified state, we're still dealing with microgram amounts, thousands of times less than we need to do a chemical characterization. Now, that may be a little bit puzzling, but if you consider that the pharmacology—the reason that we call these things toxins is because they kill at such low concentrations, then one can say that we're going to have the pharmacology and all of the toxicology done long before we have the chemical structure.

So, a long answer to the question, and, finally, when will that be done? There are actually more than one toxin that are probably named *Pfiesteria*. There is the water soluble, highly polar material that Dr. Ramsdell from National Marine Fishery talked about that they're working on with the intramural program at NIEHS and Dr. Burkholder.

Mr. GILCHREST. Do you think having, let's say, 50,000 fish killed in the Pocomoke River, I guess, doesn't give us enough of the toxin to be able to analyze it, but wouldn't you get enough of the toxin from a billion fish? There's no relationship there?

Mr. BADEN. Mr. Chairman, it's not necessarily associated with the fish. It's the concentration of the organism in toxic form at the time of the fish kill.

Mr. GILCHREST. Well, that's what I mean, but then it's—I mean, if you have a billion fish killed, it seems to me that there's more than little tiny *Pfiesteria* out there than if you have 50,000 fish killed.

Mr. BADEN. Not necessarily true, and in fact—

Mr. GILCHREST. Not necessarily true?

Mr. BADEN. Not necessarily true, and, in fact, it's the cultures of the organism in laboratory culture where you can control clonal isolates so you know what you're working with takes a lot of material,

and we're not at that stage, but we do have materials that cause lesions very similar to what are seen in the fish in purified form. There are also compounds of these more highly polar materials that are, we believe, responsible for neurological—

Mr. GILCHREST. So, since 1991, you've been collecting this material?

Mr. BADEN. Since 1991, we have been receiving extracts from Dr. Burkholder's laboratory and from Dr. Noga's laboratory on an intermittent basis in order to do that work.

Mr. GILCHREST. But, then, are you still collecting it or have you done something with it?

Mr. BADEN. Mr. Chairman, in the matter of collecting if, each extract that is placed in our hands, we go through a series of purification steps, basically, throwing away non-toxic material and amassing toxic material, and each time you do this, you get one step or two steps further into purification. Most of these purifications take 8 to 10 steps to yield homogeneous materials that can then be studied by spectroscopy which is the chemists' tools. We are nearly at that stage with the lipid soluble materials that come from *Pfiesteria*; the ones that cause the sores on fish.

Mr. GILCHREST. Dr. Burkholder, do you want to comment on any of that? Do you have an idea when you'll have enough of this stuff in a jar?

Ms. BURKHOLDER. Well, Dr. Baden's points are well taken. We, however, have made a lot of progress with folks in the last three months in getting these toxins characterized, so it is beginning to proceed much faster than in the past five years.

Mr. GILCHREST. Why is it proceeding faster in the last three months than it did in the last five years?

Ms. BURKHOLDER. I'm not really certain, because I'm not a toxin analyst. I think that the people at Nims Charleston's Marine Biotoxins Center, and, perhaps, Dr. Baden, can comment further on that at this time, but I know that a lot of effort has been poured into it by our colleagues at the biotoxins center, for example.

Mr. GILCHREST. Where was that again? In Norfolk?

Ms. BURKHOLDER. That was in Charleston.

Mr. GILCHREST. Charleston.

Mr. BADEN. Well, let me address that. We're now presently working with Dr. Ed Noga who was Dr. Burkholder's co-principle investigator on National Marine Fisheries Service, Saltonstall-Kennedy grants in the past; Saltonstall-Kennedy grants that were aimed at studying the organism as well as looking at toxin structure, and it was our subcontract responsibility from those two agreements to work on the toxins, and so we are totally at the disposal of the people that supply us with extracts in order to do the work, and we have not simply had sufficient extract from Dr. Burkholder's laboratory in order to pursue that. We have had some better success with Dr. Noga's lab over the past year and are now making rapid progress in the lipid soluble, the other toxin that's produced by this organism. We're working on different materials at this point.

Mr. GILCHREST. Dr. Burkholder?

Ms. BURKHOLDER. Yes, I will comment further that some of this seems to be a problem just in getting these toxins inventories properly, at least according to Dr. Baden's research associate, whom I

spoke with in August. Some of the batches of toxins that we sent apparently were lost and then re-recovered, so they were on the bottom of a freezer or something like that.

Mr. GILCHREST. Are they still good?

Ms. BURKHOLDER. I'm sure they are. It's just that we have been sending toxin through NIHS' intramural program to Dr. Baden, and we haven't received word back yet about what those toxins yield, so probably because there was some confusion there——

Mr. GILCHREST. They weren't lost in the mail, were they?

Ms. BURKHOLDER. No, they were apparently either inventoried and then forgotten about or somehow put to the bottom of a freezer according to the research associate.

Mr. GILCHREST. Is there sufficient communication, now, to avoid any——

Ms. BURKHOLDER. I think there is.

Mr. BADEN. Well, Mr. Chairman, we're having excellent communication this afternoon. Let's hope it gets better. I must also say that the last material that Dr. Burkholder's group has sent to us is currently in progress in parallel with control material—control, meaning non-toxic material—sent from Dr. Noga as well as Dr. Noga's extract. We're at the stage where we have non-toxic, toxic from Noga, toxic from Burkholder. Are they the same or are they different? In very short order, we will know that.

Mr. GILCHREST. That's great. We have a vote. Did you have any other comment, Mike? The rest of the day's going to be a little bit more hectic for us, and I would really like to hold all of you here for a few more hours, but that may not be possible. I hope to remain in communication with all of you so we can continue to move forward and ensure that the cooperation and the collaboration is at the highest level that is possible among people trying to figure out these complex problems. Ladies and gentlemen, thank you all very much for coming.

This meeting is adjourned.

[Whereupon, at 2:23 p.m., the Subcommittee adjourned subject to the call of the Chair.]

[Additional material submitted for the record follows.]

STATEMENT OF DONALD F. BOESCH, PRESIDENT, UNIVERSITY OF MARYLAND CENTER
FOR ENVIRONMENTAL SCIENCE, CAMBRIDGE, MARYLAND

I am Donald Boesch, President of the University of Maryland Center for Environmental Science. My perspective on today's subject is influenced heavily by my recent or continuing service as chair of two scientific committees. Earlier this year, I led a panel of experts in the completion of a report entitled "Harmful Algal Blooms in Coastal Waters: Options for Prevention, Control and Mitigation" which was requested by the Secretaries of Interior and Commerce. More recently, I have been called on by Maryland Department of Natural Resources Secretary John Griffin, who will be speaking to you later, to chair a Technical Advisory Committee to advise the State's agencies in their assessment of our fish lesion/fish kill problem about which you have heard so much about.

Although I am an ecological generalist rather than an expert on toxic dinoflagellates, I have learned a lot about these organisms over the last year from *bona fide* experts such as Dr. Burkholder, who have worked with me on these committees. Moreover, I work extensively in the Chesapeake Bay and in other parts of our country in the application of science in the solution of environmental problems and in guiding effective research. From these vantage points, I am pleased to offer my opinions on what is known about the effects of these toxic organisms, the role of human activities in stimulating them, and future research needs and approaches.

The Prevention, Control and Mitigation assessment which I mentioned earlier focused not on the basic science needs—that had been done in earlier planning reports—but on what could be done to alleviate the ill effects of harmful algal blooms, such as those that cause paralytic and amnesic shellfish poisoning, red and brown tides, and catastrophic losses of aquacultured fish. Unfortunately, we did not also include *Pfiesteria*. I am providing copies of our report for the Subcommittee. Our report concluded that although pollution and nutrient enrichment have been strongly implicated in worsening harmful algal blooms in various parts of the world, they have not yet been unequivocally identified as the cause of any of the U.S. blooms considered in our assessment. Nonetheless, we concluded that conscientious pursuit of goals for reduction of pollution, especially excess nutrients, could well yield positive results in terms of reductions in harmful algal blooms.

In terms of research needs, suffice it here to say that our conclusions also included recommendations for issues related to prevention and control that should be addressed by fundamental research and a specific call for expanded Federal research directly addressing prevention, control and mitigation. Should include: evaluation of the effectiveness and side-effects of chemical, physical and biological controls; development of better measurements of toxins and harmful algal species for application in monitoring; ballast water treatment; and effects of chronic exposure on human health.

Turning now to the Chesapeake, let me summarize briefly where we are. First, after evaluating a variety of potential causes of the fish lesions that were first observed in the Pocomoke River last fall, it now appears highly likely that many of these lesions, as well as the fish kills that were witnessed this summer, were caused by toxins released by *Pfiesteria piscicida* or one of two other dinoflagellates that have been identified. In addition, medical researchers have documented skin rashes and reduced efficiency in short term memory function in now over two dozen individuals exposed to the river water. This has raised concern by a quantum and resulted in a variety of steps to ensure the protection of public health. I am sure that Secretary Griffin will be happy to tell you more about this.

The scientific team and advisors are turning their attention in particular to the environmental conditions that promote the outbreaks of toxic forms of *Pfiesteria*-like organisms, not only so that we can predict where they may occur and appropriately protect the public, but that we can better control human activities that may stimulate them. As you know, nutrient over enrichment, particularly from agricultural sources, has been suspected. Maryland Governor Parris Glendening has charged a Blue Ribbon Citizens *Pfiesteria* Commission to recommend steps that can be taken to reduce the risks of *Pfiesteria*. More effective controls of nutrient losses from agricultural activities, including the disposition of poultry manure, are among the principal issues under review. Environmental and agricultural scientists from University of Maryland institutions are presently working with the Commission to develop scientific consensus regarding the relationships between nutrients and *Pfiesteria*-like organisms, review the effectiveness of present nutrient and waste management strategies, and lay out for the Commission potential improved strategies.

I believe that Dr. Burkholder would agree that we are still on the early part of the *Pfiesteria* learning curve. Her contributions have been truly monumental, but we have only had a small group of scientists working for about six years on these

extremely complex organisms. With a stronger case now made because of documented health concerns and the greater number of regions potentially affected—not to mention the heightened national concern represented by media attention—clearly more research is required. And, there is certainly a major Federal responsibility for this research. I urge that Congress insist that it: is strategic in that research programs emphasize the most critical question; is integrated across agencies and disciplines; incorporates high standards of scientific quality and peer review; and is accountable in what will be expected to lead to clearer understanding and, to the extent possible, solutions.

From the perspective of Maryland's Technical Advisory Committee (which, by the way, includes experts from the Carolinas and Virginia) the environmental research priorities are: (1) resolving the relationship between land-based pollution, particularly by excess nutrients, and *Pfiesteria*-like organisms on scales from the cell to the watershed; (2) developing modern molecular methods for detection and quantification of toxins and organisms; (3) determining the effects of these toxic dinoflagellates on fish and shellfish populations (i.e. going beyond the effects on the health of an individual fish); and (4) determining the degree to which toxins may be retained in fish and shellfish tissues. In addition, of course, there are additional priorities for health and agricultural research.

In my opinion, an effective mechanism already exists for the support, direction and coordination of the needed environmental research in the form of the NOAA-led program on the Ecology and Oceanography of Harmful Algal Blooms (ECOHAB). ECOHAB has already developed research strategies dealing with other harmful algal species based on planning by the scientific community. It is broadly focused and integrated, incorporating approaches from molecules to water circulation to ecosystems. A number of agencies already participate in ECOHAB, including EPA, the Office of Naval Research and the National Science Foundation, in addition to NOAA. And, ECOHAB has an in-place management and review structure that accommodates the participation of both university and Federal-laboratory based scientists.

Finally, I am pleased that the Federal agencies are preparing a coordinated response plan related to *Pfiesteria*. It is important that the appropriate health, environmental, and agricultural agencies be involved and that their contributions are in balance and in collaboration. Similarly, the university research community in the affected Mid-Atlantic and southeastern states includes incalculable talent; physical capabilities; experience with coastal environments, communities, and fishing and agricultural enterprises; and working relationships with the states. My colleagues and I not only stand ready to contribute these intellectual and physical resources, but also have been leading in the development of creative scientific strategies to address the problems. We look forward to working closely and cooperatively with the Federal agencies toward these ends.

STATEMENT OF DANIEL G. BADEN, PH.D.

I would like to express my gratitude to the Subcommittee for giving me this opportunity to address issues relating to the status of Federal and State research into Harmful Algal Blooms and in this context, to outbreaks of *Pfiesteria*.

Toxic marine phytoplankton are responsible for "red tides" or "harmful algal blooms" (HAB). HABs occur in virtually all coastal areas of temperate and tropical seas, and are responsible for five known types of seafood poisoning in man. Specific HAB incidents are often geographically localized but their occurrence is sporadic. As I speak, in addition to the *Pfiesteria* and other fish killer HABs in the mid-Atlantic region, Texas and other states on the Gulf of Mexico are experiencing Florida red tide outbreaks. These red tides are notorious for tons of dead fish per day per mile of coastline. All HABs are natural events induced or permitted by specific environmental conditions.

HABs are also implicated in mass marine mortalities known as epizootics. In the past 20 years red tide toxins have been implicated in the deaths of bottlenose dolphins in Hawaii, manatees in Florida, pilot whales in the Northeast U.S., pelicans on the U.S. West coast, cormorants and gannets (seabirds) on the East coast of the U.S., fish along the entire Gulf of Mexico coastline and also stretching from the Carolinas up to and including Maryland coastal zones. More tenuous links to HABs have been suggested for bottlenose dolphin mortalities on the Atlantic seaboard, sea turtles in the Gulf of Mexico and Hawaii, and monk seals in the Mediterranean Sea. As "sentinel" or indicator species in the oceans, marine animals are akin to the canaries taken into mine shafts—their death or sickness is an indication of the degradation of local environmental conditions.

Questions concerning environmental parameters conducive to HAB development, maintenance, and termination test our oceanographic knowledge base. Questions concerning our ability to detect and/or predict blooms as they develop address components of marine biotechnology, coastal zone nutrient loads, and life cycle biology. Questions concerning effects on marine animals touch on aspects of biomedical research (that is using diagnostics and therapeutics developed for treating human HAB exposures), detection technologies, and whole animal physiology.

Federal and State programs that address each of these research questions individually are currently in place, but holistic research that addresses the interface between research areas is lacking. Thus, Departments of Commerce, Defense, Health and Human Services, and Agriculture need to coordinate with one another and develop partnership funding strategies. All appropriate agencies should be involved.

Likewise, basic scientists, clinicians, oceanographers, ecologists and taxonomists all must develop better ways of interaction and communication, essentially by developing interdisciplinary approaches to their science. In other words, those activities that are land-oriented and those that are ocean or aquatic-oriented need to be coordinated in the coastal zone. Over half of the U.S. population resides within 50 miles of a coastline. It is in the coastal zone that HABs occur, that marine animal deaths have been documented, and that coastal nutrients are changing. Over the past decade, several dynamic interdisciplinary approaches to harmful algal bloom science have developed. But the coordinated multiagency funding packages have not kept pace with the interdisciplinary nature of the science.

Harmful algal blooms produce some of the most potent toxins known to man, potencies only exceeded by the more familiar protein toxins, like botulism toxins. HAB organisms are often toxic throughout their life cycle. There are of course exceptions like *Pfiesteria* that exhibit toxic phases. Because of their high intrinsic toxicity, exceedingly small amounts are required to induce lethality. Even smaller quantities may be accumulated and cause sub-lethal metabolic and/or neurotoxic abnormalities. In the area of sub-acute toxicological effects, we need more research to completely define the consequences of exposure, to understand the toxic mechanisms at the molecular level, to design antidotes or therapies, and ultimately to develop preventative strategies for man and animal alike. This is an interdisciplinary area that should be addressed by NIH, NSF and DOC.

We need more research directed at HAB initiation, progression, and termination. Concurrently, it is essential we develop testing methods and other tools that can accurately measure the numbers of HAB organisms at the beginning of a bloom. We currently know so little about triggering or sustaining factors that this is an area of active interest in all regions of the U.S. As many as 20 different marine microorganisms produce HABs, and each has individual ecological requirements. Factors beneficial to one species may be detrimental or inconsequential to yet another species. Much of this work is done at the State levels, traditionally related to seafood safety issues. There is a need here for Federal/State partnerships for research and information sharing. There is a decided need for specialized programs for development of test kits, perhaps by partnership with the biotechnology industry.

We need to develop testing protocols that can measure toxin movement through food chains, and within the organs and tissues of exposed animals. Without this information, it is impossible to precisely measure the total ecological consequences of HAB events. In addition, with the implementation of the Hazard Analysis Critical Control Point (HACCP) program for seafood in December of 1997, there is a desperate need for bringing all tests into use and certification.

We already know a great deal about how much and what types of toxin in seafood produce illness in man. We surmise, therefore, that any animal that consumes the same seafood is also subject to attack by the neurotoxins. Tests, therapeutics, and diagnostics developed by DOD and DHHS for humans have great potential for marine animals as well. One classic example of this cross-fertilization is the work done in Florida on the 1996 manatee epizootic. Diagnostic and analytical methods for brevetoxin detection in human biological fluids, developed using NIEHS funds awarded to the University of Miami Center, were used to precisely measure the amounts of brevetoxin present in tissue samples. This work was done in conjunction with marine mammal pathologists from the State of Florida. As a result of the study, a new analytical immunocytochemical test was developed; a test that may prove of value in precisely quantifying human illness or for seafood testing programs.

Informatics is extremely important in all of these research areas, and a detailed set of databases should be established, beginning with a survey of the databases already available. This can be done electronically, much in the same way as the current human genome project. This area is important for funding. Federal programs that address informatics should certainly play a great role in this endeavor.

Finally, stable funding for the science, in academic laboratories and at the State and Federal level, is necessary so that we can produce rapid response teams to address pressing HAB problems. It often seems that funding runs about 9 months behind toxic events, and universities are increasingly reluctant to provide the fiscal support to carry out rapid response projects.

I again would like to thank the Subcommittee for the invitation to address these issues. I hope my testimony has provided information that will assist you in your deliberations.

Testimony of

Terry D. Garcia

Acting Assistant Secretary of Commerce for Oceans and Atmosphere
National Oceanic and Atmospheric Administration

Before the

Subcommittee on Fisheries Conservation, Wildlife and Oceans
Committee on Resources
U.S. House of Representatives

October 9, 1997

Good morning, Mr. Chairman and members of the Subcommittee. I am Terry Garcia, Acting Assistant Secretary of Commerce for Oceans and Atmosphere. I appreciate the opportunity to discuss NOAA's role in the multiagency response to the *Pfiesteria* crisis in the Chesapeake Bay, as well as its context in a much larger set of national issues surrounding harmful algal blooms, hypoxia, and the control of nutrients entering our coastal waters. NOAA's efforts are occurring on two important and related fronts: (1) research, and (2) management, supported by education and outreach. Regarding research, NOAA and the Environmental Protection Agency (EPA) are leading a national effort, on behalf of the White House and coordinated with state and academic scientists, to develop short-term and long-term research strategies from both regional and national perspectives focused on understanding and assessing the causes and consequences of the recent

Pfiesteria bloom and other similar harmful algal blooms. This national research strategy focuses on four areas: 1) methods to identify and detect the toxins; 2) determining toxin pathways and the means to forecast harmful blooms and impacts; 3) developing management and mitigation options, including a rapid response capability; and 4) enhancing education and outreach. The draft plan, which will be ready for review by Federal and state agencies and the academic community this month, is intended to provide an excellent base from which to build control and mitigation strategies through our coastal management programs, to reduce and prevent the occurrence of future harmful blooms.

In addition to our internal scientific research capabilities, NOAA is also home to the Sea Grant and Coastal Ocean programs. These programs are playing important roles in coordinating state and Federal research and management activities in marine waters and are important mechanisms for ensuring that states are provided with the best available information as they develop management measures to combat *Pfiesteria* and other harmful blooms. The NOAA Chesapeake Bay Office is leading a regional interagency team to coordinate immediate Federal responses specific to mid-Atlantic state needs.

Regarding management, NOAA, in partnership with EPA and the coastal states, has been working since 1990 to implement the Coastal Non-point Pollution Control Program, providing the tools necessary to

control land-based sources of pollution that impact coastal waters. NOAA's Chesapeake Bay Office is further supporting the management efforts of Pennsylvania, Maryland, and Virginia through the Chesapeake Bay Program by assisting in a regional analysis of water quality; identifying nutrient and contaminant inputs to the Chesapeake Bay and providing results to determine long-term trends in nutrient distributions, phytoplankton biomass, and dissolved oxygen in response to management actions in the Bay's watershed. These data provide critical baseline information for identifying conditions which may support *Pfiesteria* blooms. Moreover, as part of our new mandate to describe and identify essential fish habitat under the Magnuson-Stevens Fishery Conservation and Management Act, NOAA will be identifying important sources of non-point source pollution that are likely to adversely affect such essential fish habitat and recommend state or Federal agency actions to control such sources of pollution. Evidence of past and present harmful algal blooms, hypoxia conditions and high incidence of fish lesions, fish kills and toxic events from *Pfiesteria*-like organisms will become focus areas for NOAA and the Fishery Management Councils to make specific recommendations on controlling such problems.

Before I outline NOAA's efforts related to the recent Chesapeake Bay *Pfiesteria* outbreaks, I want to first take a moment to make the point that this microbe is one of a larger set of potentially harmful

species that are apparently increasing in abundance and intensity in coastal waters, both here and abroad. These harmful algal blooms -- including red tides in the Gulf of Mexico and the southeast; brown tides in New York and Texas; and shellfish poisonings in the Gulf of Maine, the Pacific Northwest, and Alaska -- impact nearly every coastal state and have been responsible for an estimated \$1 billion in economic losses over the past two decades. The blooms have decimated the scallop fishery in Long Island's estuaries, killed a billion fish in North Carolina estuaries, closed down various shell fisheries on Georges Bank and from North Carolina to Louisiana, and killed almost 150 Florida manatees. These harmful algae have been associated with the serious die-off of dolphins along the East Coast in 1987 and, without effective means to monitor for paralytic shellfish poisoning, over 30,000 miles of Alaskan shellfish waters cannot be harvested. And as we meet here today, a Texas red tide stretching along South Padre Island and the Padre Island National Seashore has killed an estimated 4.2 million Gulf menhaden, scaled sardine, Atlantic bumper, and striped mullet.

These harmful algal blooms, which include *Pfiesteria*, are composed of naturally occurring species that for some reason reproduce out of control (i.e., "bloom"), out of the natural ecosystem balance, and manifest themselves in various forms, such as discolored waters and fish kills, all of which can have human health

effects. While the specific environmental conditions which result in blooms vary from species to species, the increasing coast-wide and world-wide trends in bloom occurrence and intensities suggest we should look for some common underlying causes, such as increased levels of nutrients in coastal waters. Therefore, efforts to prevent, control, or mitigate the impacts of *Pfiesteria* in the mid-Atlantic should be approached in a context of the causes and consequences of the broader set of harmful algal blooms affecting marine waters recently.

I should also point out that excess nutrient loads, particularly nitrogen and phosphorus, are also responsible for a general overgrowth of algae in many coastal ecosystems. While these algae may not be toxic, their death and subsequent decay can lead to severe oxygen depletion in the bottom waters of many estuaries and coastal environments. In fact, a recent NOAA survey has revealed that at some time each year 53 percent of our estuaries experience hypoxic conditions (e.g., oxygen levels low enough to cause significant ecological impairment) and 30 percent experience anoxia (e.g., areas where all of the oxygen is depleted). These statistics, along with the dramatic hypoxic zone that covers over 7,000 square miles of the northern Gulf of Mexico, are clear symptoms of over-fertilized marine systems. The ultimate solutions to many of the problems we are addressing today - from *Pfiesteria* to other toxic algal blooms to

severely depleted oxygen - will be based on an ability to predict the fate, transport, and impacts of nitrogen and phosphorus in coastal watersheds and water bodies.

Let me now summarize NOAA's involvement in recent events in the Chesapeake Bay and with harmful algal blooms in general. Before the *Pfiesteria* event on the Pocomoke, NOAA had been providing funds for harmful algal bloom research, education, and outreach through its network of Sea Grant Universities and the Coastal Ocean Program. In fact, Sea Grant supported some of the earliest research on the problem of fish lesions and the causative organism *Pfiesteria* through basic research on the taxonomy, physiology, toxicology, and ecology of this organism, beginning in the late 1980's and continuing through the present. This research led to the discovery of the organism, as well as a better understanding of some of the initial observations, which are now available to many through a world-wide-web home page on research at North Carolina State University. The North Carolina Sea Grant Program is currently using state funds to support researchers in three projects assessing the human health risks of *Pfiesteria* to watermen and to seafood consumers. Scientists in a fourth research project are investigating the role of nutrients in stimulating *Pfiesteria* blooms in North Carolina. Maryland and Virginia Sea Grant also have generated websites, newsletters, and fact sheets on *Pfiesteria* and its impact in the Chesapeake Bay, providing advice and

outreach to officials, commercial and recreational fishermen, and the public. In addition, as part of Sea Grant's Biotechnology Initiative, \$446,000 in federal and state matching funds were dedicated to developing a probe to identify *Pfiesteria*. Successful tests on water samples from these recent fish kills have been completed and further testing is ongoing in Maryland. The Gulf of Maine Regional Marine Research Program, a joint NOAA/EPA program, chose harmful algal blooms in 1992 as one of the two long-term research needs to focus its multimillion dollar research program with the general goal of developing an understanding of how the Gulf of Maine ecosystems, and its interacting components, function naturally and under stress.

In response to this immediate crisis on Maryland's Eastern Shore, NOAA and EPA have each provided \$250,000 in emergency assistance to Maryland so that monitoring and assessment efforts could get underway quickly in the Pocomoke River watershed. Our Chesapeake Bay Office, working with EPA's Chesapeake Bay Program Office, is coordinating this Federal interagency response to the Maryland *Pfiesteria*-like outbreaks. Working with Maryland officials from the Departments of Natural Resources, Environment, and Agriculture, these efforts have resulted in a coordinated state-federal effort of weekly-to-biweekly monitoring; post-storm event assessments of water quality, toxins, fish populations,

histopathologies, and microbial pathologies; fish bioassay experiments; analysis of toxins in sediments; and watershed loads of nutrients and agricultural chemicals. These rapid response activities are designed to characterize the *Pfiesteria*-like dinoflagellates assumed to be causing the fish lesions and fish kills, what fish tissues are affected, and what unique environmental conditions may be responsible for the outbreaks. NOAA has also provided a research vessel and staff in Shelldown to assist in Maryland's "swat-team" approach to respond to reported fish lesion or fish kill events. NOAA scientists, serving on Maryland's Fish Health Technical Advisory Committee, are providing expert advice and guidance to the State on responses to blooms in the Pocomoke and other Bay tributaries and on guiding future research through identification of critical missing data.

NOAA scientists in Oxford, MD, are contributing to fish pathology studies at the NOAA-Maryland Cooperative Oxford Laboratory, focusing on histopathological and tissue assays from lesioned fish and, in collaboration with University of Maryland researchers in College Park, microbiological pathologies of the same fish. This work has been invaluable in determining possible linkages between lesions and lesion-causing substances in plankton or in the water from dissolved toxic residues left by the plankton. In partnership with the National Institute of Environmental Health Sciences and

North Carolina State University, researchers at our Charleston Laboratory have made great progress in identifying and purifying the water-soluble toxin emitted by *Pfiesteria*, paving the way for routine methods of field detection of this *Pfiesteria* toxin and for performing critical dose-response experiments that are an integral part of the seafood safety determination process. Marine biologists at NOAA's Beaufort Laboratory in North Carolina have been collaborating with Dr. Burkholder of North Carolina State University in preliminary work on defining conditions favorable to the growth of non-toxic stages of *Pfiesteria*, the most prevalent life stages of this animal in coastal systems. These data are essential to understanding optimal growth conditions for this problematic species and ultimately preventing, or at least predicting, impending onset of blooms.

As mentioned earlier, nitrogen and phosphorus are pivotal nutrients in the Chesapeake Bay and other coastal systems. Considerable effort has been placed on improving water quality by controlling nutrient load to the Chesapeake Bay, and there is growing evidence that nutrients may play an important role in the *Pfiesteria* blooms. NOAA's Air Resources Laboratory is actively investigating atmospheric nutrient loading to the Chesapeake watershed, providing critical estimates of both wet- and dry-fall loadings of nitrogen. While clearly significant Bay-wide, these inputs may also be a

component of the conditions necessary for persistence of Bay *Pfiesteria* populations.

NOAA has been a long-term partner with EPA in the Chesapeake Bay Program through the activities of the NOAA Chesapeake Bay Office. NOAA has funded since the late 1980's an aircraft remote sensing study of algal blooms in the Chesapeake. This project is providing insight into the driving forces of algal abundance and distribution in the Bay, including nutrients, rainfall, temperature, and other factors--many of the same factors likely to be controlling *Pfiesteria*-like blooms. NOAA also recently completed comprehensive surveys of the Chesapeake Bay and other estuaries in the mid-Atlantic region to document the chemical, biological, and physical conditions contributing to nutrient enrichment, eutrophication, and occurrences of nuisance and toxic algal blooms. With millions of dollars spent on reducing nutrient loads to the Bay through sewage treatment upgrades and implementation of best management practices in agricultural and developed areas, NOAA's role in determining the Bay's response to managed inputs provides a barometer of our success in reducing pollutant and nutrient loading. In addition, these data provide critical baseline information for identifying conditions which may support *Pfiesteria* blooms.

As evidence grows that these and other blooms are stimulated by the availability of non-point sources of nutrients, our efforts with

EPA and the states through our Coastal Zone Management, Non-point Pollution Control Program will be critical. For the past seven years, NOAA, EPA, and the coastal states have been working to identify programs available to address non-point sources of pollution and to ensure that appropriate management practices are applied to reduce polluted runoff. The development of state coastal non-point programs has provided a road map of what we need to do, and has identified existing tools and areas where more effort will be required.

The coastal non-point program applies to 31 coastal states and territories and addresses sources of polluted runoff from agriculture, forestry, urban development, marinas and recreational boating, as well as the impacts associated with the construction and maintenance of dams and channels, and other alterations of natural systems. The program is administered at the state level by a variety of state and local agencies through implementation of existing authorities, plans, and projects. NOAA and EPA have begun issuing approval decisions for state coastal non-point programs. Maryland has received approval for its coastal non-point program, subject to conditions related to agriculture, new and operating septic systems, and marinas.

NOAA and EPA have generally found that state voluntary programs, backed by existing water quality laws and regulations, have not yet

shown the ability to ensure control of polluted runoff from agricultural sources, including confined animal facilities, application of fertilizer and animal waste, pesticide application, and grazing. States may also lack specific technical tools with which to design and implement the kinds of controls necessary to reduce polluted runoff from urban areas, forestry operations, and marinas.

Where improved management cannot be achieved through voluntary programs, states will need to identify how existing or new authorities can be used to improve management and identify ways that states can measure success. Using agriculture in the Pocomoke River watershed as an example, Maryland needs to determine current levels of runoff control. What is the acreage within the Pocomoke watershed currently covered by nutrient management plans? Are existing nutrient management plans being adequately implemented? Where nutrient management plans have not yet been developed or are not being adequately implemented, the State will need to take actions to ensure that plans are upgraded and implementation is improved.

NOAA will continue to support the states and other Federal agencies in responding to this immediate, urgent problem. However, significant and lasting progress on this problem will require a comprehensive, coordinated, and integrated strategy to understand the factors responsible for high incidences of fish lesions and fish

kills, and for blooms of *Pfiesteria* and of other harmful blooms; and develop and implement strong management approaches to address human activities with the potential to impact coastal waters. Plans for such longer-term research on *Pfiesteria* are being developed and coordinated among Federal agencies and with state and academic scientists. These research efforts, in turn, provide an excellent base from which to build control and mitigation strategies through our coastal management programs, to reduce and prevent the occurrence of future harmful algal blooms. Despite the fact that the coastal non-point program has not received an appropriation for the past two years, NOAA is committed to working with states to take the action necessary to reduce polluted runoff. The road map for each state exists in their coastal non-point programs. The challenge will be to implement them.

However, as I indicated earlier, *Pfiesteria* is symptomatic of a growing national problem of polluted runoff and harmful algal blooms. NOAA has recognized this problem and has developed a national research strategy to assist in identifying better means of controlling polluted runoff. NOAA's coastal ocean program has led development of a multi-agency research program on the Ecology and Oceanography of Harmful Algal Blooms. This ongoing program - called ECOHAB - is a partnership among NOAA, the National Science Foundation, the Environmental Protection Agency, and the Office of

Naval Research. It is the first Federal interagency research program focused exclusively on determining factors responsible for blooms of harmful algae in U.S. coastal waters, and developing predictive capabilities to aid in forecasting bloom events, which could lead to the development of effective management and control policies. Current efforts, supported by ECOHAB on New York brown tides, and efforts about to be initiated on Florida and Gulf of Maine red tides, are convincing us of the importance of supporting integrated, region-scale research on the causes and consequences of harmful blooms. That research can then form the basis of predictions and forecasts of bloom incidences, and can be used to develop means to prevent, control, or mitigate their impacts. This is the model that should be applied toward combating the *Pfiesteria* problem.

As we move forward in dealing with *Pfiesteria* and other harmful algal blooms, NOAA will continue to work with the states, and will coordinate Federal monitoring and assessment in the Chesapeake region. We will lead development of a national interagency program that includes: 1) research to understand and predict conditions favoring *Pfiesteria* bloom development and toxicity as a part of the national approach to harmful algal blooms in the U.S.; 2) assessment of the human health and economic impacts on coastal communities and seafood consumers; 3) further development and implementation of appropriate management measures to control and mitigate those

impacts; and 4) expanded outreach efforts to ensure that coastal managers and the public can make informed decisions dealing with fish kills, lesions, and safeguards to public safety.

Mr. Chairman, that concludes my testimony. I would be pleased to answer any questions that you or other members may have.

PFIESTERIA PISCICIDA AND OTHER TOXIC PFIESTERIA-LIKE DINOFLAGELLATES

JoAnn M. Burkholder, Pew Fellow, North Carolina State University, 2 Oct. 1997

Discovery and Distribution

The toxic dinoflagellate, *Pfiesteria piscicida* Steidinger & Burkholder, was first found as a culture contaminant of unknown origin in fish cultures at the North Carolina State University College of Veterinary Medicine.¹ It was first identified in the wild during 1991 as a causative agent of major fish kills in the Albemarle-Pamlico estuarine system of North Carolina in the southeastern United States². This system contributes approximately half of the surface area used as nursery grounds for fish species from Maine to Florida, and it is the second largest estuary on the U.S. mainland³. *Pfiesteria piscicida* also has been tracked to fish kill/ disease sites in the Delaware Inland Bay system (which is as far north as sampling for it has occurred), and to fish kill/disease sites in several rivers in Chesapeake Bay⁴. Since 1991, *P. piscicida* has been implicated as a significant causative agent of major fish kills in the Albemarle-Pamlico (10^3 to 10^9 finfish and shellfish)⁴. More recently, it has been identified as a causative agent of both fish kills and fish disease in cultured and wild fish from certain areas of Chesapeake Bay⁵. There are now 20 peer-reviewed publications in the scientific literature on *Pfiesteria*-like dinoflagellates, 18 of which were authored or co-authored by members of my laboratory along with more than 15 colleagues in other laboratories who have led some of the most important research efforts (e.g., colleagues who have begun to develop molecular probes for rapid, reliable identification of *Pfiesteria piscicida* and other toxic *Pfiesteria*-like species; research to understand the impacts of *Pfiesteria*'s toxins on mammals and, by analogy, humans; and toxin analysis).

In 1991 (peer-reviewed publication in the science journal, *Nature*), I predicted that multiple species with wide geographic distribution would be found with similar appearance to *Pfiesteria piscicida*, and toxic attack behavior toward fish.² Two other similar toxic *Pfiesteria*-like species recently have been found from Maryland south to the Gulf Coast⁵. These species have been distinguished on the basis of slight differences in cell structure; differences in genetic composition have not been determined, and cross-reproduction tests would be useful to confirm that they are, in fact, separate species. They appear to show extremely similar behavior toward targeted fish prey, and thus far also have similar complex life cycles that include multiple flagellated, amoeboid, and encysted stages. The stages or forms of *Pfiesteria piscicida* have a 90-fold range in size (length 5 to 450 μ m, below). Among the three toxic species known thus far, the only one that has been named is *Pfiesteria piscicida*⁶; hence, this group of dinoflagellates is loosely known as the "toxic *Pfiesteria*



Nontoxic Zoospore
(10 μ m)

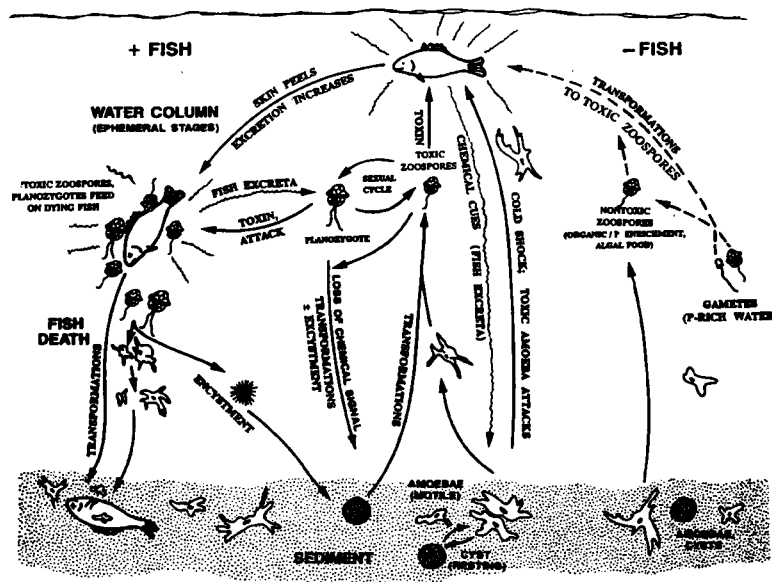
Toxic Zoospore
(12 μ m)

Zoospore Cyst
(16 μ m)

Lobose Amoeba
(120 μ m)

Lobose Amoeba
Cyst (30 μ m)

complex.⁵ A fourth "lookalike" species is known from the Chesapeake and Albemarle-Pamlico, but it has not yet been tested for potential toxic activity toward fish^{5,7}.



Feeding controls on stage transformations of the representative toxic dinoflagellate, *Pfiesteria piscicida* (not to scale). In the Albemarle-Pamlico estuarine system during warmer seasons (water temperatures greater than 70°F), several stages in the water column can release toxins that immobilize and kill fish prey. Flagellated stages (with whip-like structures, flagella, for swimming: toxic zoospores, sexual cells or gametes, and motile sexual products or planozygotes) attack fish and feed on their excreta, secretions, and tissues. After fish death, under adverse conditions these flagellated forms sink to the muds on the bottom of the estuary and form hibernating structures or cysts; alternatively, if fish remains or other foods are accessible, they transform into nontoxic zoospores or amoebae and continue to feed. In North Carolina waters under colder temperatures (50-60°F), larger lobose amoeba stages can attack fish with similar behavior as shown by toxic zoospores in warmer seasons. When fish are absent, active amoebae persist in the bottom muds of the estuaries and, less commonly, in the water column as long as microbial prey are available. Gametes (produced by toxic zoospores when stressed fish are present) generally remain active after transforming to amoebae in nutrient-enriched waters. Alternatively, upon fish death, gametes and toxic zoospores revert to nontoxic zoospores when flagellated algal prey are abundant, especially under nutrient-enriched conditions. Lobose amoebae can also produce nontoxic zoospores when flagellated algal prey are abundant. This schematic was based on data from more than 100 trials (hours to weeks in duration) in which fish access was varied.⁵

In laboratory experiments *Pfiesteria piscicida*, the best studied among the toxic *Pfiesteria* complex, has been demonstrated to cause lesions in fish that become colonized by opportunistic bacteria and fungi^{4,5}. This phenomenon is sometimes called ulcerative mycosis in the commercially

important species, Atlantic menhaden (*Brevoortia tyrannus* Latrobe), fish that form large, dense schools and are known for copious oily secretions which stimulate *P. piscicida*⁸. Atlantic menhaden have comprised about 90% of the affected fish in *Pfiesteria*-related kills, although most other finfish and shellfish within a toxic outbreak area also die.⁵ Striped bass have been most sensitive to *P. piscicida*'s toxins among finfish species tested thus far, and hemorrhaging often occurs prior to death. *P. piscicida* also has been linked to immune system suppression, neurological impairment, and other sublethal/chronic health impacts in finfish, and to shellfish diseases as well (e.g., shell disease in blue crab)⁹. Toxins are contained in both water-soluble and lipid-soluble fractions, based on data testing impacts to fish and mammalian tissues from the author's laboratory in conjunction with the Intramural Program of the National Institute of Environment Health Sciences and the National Marine Fisheries Service Marine Biotoxins Center, Charleston.

Species of finfish and shellfish that have been killed in natural habitat with active stages of toxic *Pfiesteria*-like species, or in culture bioassays containing active stages of *Pfiesteria piscicida*. Asterisks (*) indicate confirming aquarium bioassays on adults (A), pediveliger larvae (P), or juveniles (J); mortality of remaining species occurred during field or aquaculture kills in which *Pfiesteria piscicida* and other *Pfiesteria*-like species were implicated as the causative agents (based on quantification of toxic stages at greater than 250 cells/mL in water samples from the in-progress kills, and scanning electron microscopy procedures to verify identification). The best studied representative species, *Pfiesteria piscicida*, has proven lethal to all tested finfish and shellfish.

Native estuarine/marine species		
American eel	<i>Anguilla rostrata</i> Lesueur	A
Atlantic croaker	<i>Micropogonias undulatus</i> L.	*A
Atlantic menhaden	<i>Brevoortia tyrannus</i> Latrobe	*A, J
Bay scallop	<i>Argopecten irradians</i> Lamarck	*A
Black grouper	<i>Mycteroperca bonaci</i> Poey	A
Blue crab	<i>Callinectes sapidus</i> Rathbun	*A
Channel catfish	<i>Ictalurus punctatus</i> L.	A
Eastern oyster	<i>Crassostrea virginica</i> Gmelin	*P*
Hogchoker	<i>Trinectes maculatus</i> Block & Schneider	A
Killifish (mummichog)	<i>Fundulus heteroclitus</i> L.	*A
Largemouth bass	<i>Micropterus salmoides</i> Lacepede	A*
Mosquitofish	<i>Gambusia affinis</i> Baird & Girard	*A
Naked goby	<i>Gobiosoma bosc</i> Lacepede	A
Northern quahog (littleneck clam)	<i>Merccenaria mercenaria</i> Linne	J, A
Pinfish	<i>Lagodon rhomboides</i> L.	A
Red drum	<i>Sciaenops ocellatus</i> L.	*A
Readear sunfish	<i>Lepomis microlophus</i> L.	A*
Sheepshead	<i>Archosargus probatocephalus</i> Walbaum	A
Southern flounder	<i>Paralichthys lethostigma</i> Jordan & Gilbert	*A
Spot	<i>Leiostomus xanthurus</i> Lacepede	*A
Spotted sea trout	<i>Cynoscion nebulosus</i> Cuvier	A
Striped bass	<i>Morone saxatilis</i> Walbaum	*A
Striped mullet	<i>Mugil cephalus</i> L.	A
White perch	<i>Morone americana</i> Gmelin	*A
Exotic (introduced) species		
Clownfish (clown anemonefish)	<i>Amphiprion percula</i> Lacepede	*A
Goldfish	<i>Carassius auratus</i> L.	*A
Guppy	<i>Poecilia reticulata</i> Peters	*A
Hybrid striped bass	<i>Morone saxatilis</i> x <i>Morone chrysops</i> Rafinesque	*A, J
Tilapia	<i>Oreochromis aureus</i> Steindachner, <i>Oreochromis mossambicus</i> Peters, <i>Tilapia nilotica</i> L.	*A

*Confirming bioassays on eastern oyster pediveliger larvae were completed by G. Krantz with J.M.B. and H.B.G.

*Largemouth bass and redear sunfish are considered freshwater species, but they were found in slightly brackish waters

Pfiesteria piscicida and *Pfiesteria*-like species often are nontoxic microscopic animals that consume bacteria, algae, other small animals, and dissolved organic nutrients¹⁰. Thus far, they are only known to become toxic when they detect substances excreted/secreted by live fish, or leached from their fresh tissues^{2,5}. There is strong chemical sensing of fish by these predatory dinoflagellates, and when they detect enough of the fish stimulatory substances, they begin to produce toxins that are sent out into the water. The fish, in turn, must be affected by the toxins to the extent that they become narcotized and lethargic, with reduced ability to leave the area so that they are subjected to lethal levels of toxins. This two-way chemical communication is required for *Pfiesteria* to be able to cause fish disease and fish kills. The optimal setting for toxic activity of *Pfiesteria*-like dinoflagellates is poorly flushed estuaries and upper embayments, protected from strong wind and wave action which mix the water and dilute both fish excreta and the toxins that are produced in response. Optimal "ingredients" for toxic *Pfiesteria* activity are brackish conditions (half fresh and half salt water or 15 psu) and warm temperatures⁴. However, *Pfiesteria piscicida* is capable of killing fish and promoting fish disease in freshwater (0 psu salinity) as long as calcium is available (ca. 20 mg calcium hardness/L or greater), and at full-strength marine salinities (35 psu). As mentioned, it also has wide temperature tolerance, with lethal activity known so far in the range of about 50-90°F⁴.

Implicating the "Toxic *Pfiesteria* Complex" as Causative Agents of Fish Death and Disease

To implicate *Pfiesteria piscicida* or other *Pfiesteria*-like species in finfish and shellfish kills or disease events, we error on the side of conservatism^{4,5}. If other causative agents are present (for example, chemical spills, other microbes that cause fish disease), the toxic *Pfiesteria* complex is not invoked as primary causative agents. The estuaries where these dinoflagellates occur tend to be nutrient over-enriched, and it is common for dissolved oxygen to be less than levels recommended for good fish health in the lower one-third of the water column. The fish attacked by the toxic *Pfiesteria* complex are mostly surface-schooling, meaning that they generally are found near the water surface where oxygen is most available. If dissolved oxygen is low in *more* than the lower third of the water column -- that is, lower than levels that are considered to promote good fish health, at the time of day near dawn when oxygen demands tend to be greatest in estuaries -- then we invoke low dissolved oxygen as the primary causative agent of the fish kill or disease event, and if *Pfiesteria* or *Pfiesteria*-like species were present at toxic levels (> 100 cells/mL for disease, and ≥ 250 cells/mL for kills)^{2,4}, they are implicated as secondary causative agents.

To help regulatory agencies detect the presence of toxic *Pfiesteria* populations in Maryland and other states, we complete a three-step process⁵. First, we collect both "fresh" (not poisoned) and "preserved" water samples (poisoned with a chemical that kills all dinoflagellates and other cells) from an in-progress fish kill or fish disease event. That is, samples are collected while the fish are dying or showing obvious signs of sickness. We complete a "presumptive" count on the preserved water samples with a light microscope (600x magnification) to see whether we can detect potentially toxic concentrations of *Pfiesteria*-like species in sufficient densities to cause fish disease or kills. If we do not find such cell densities, we rule out the toxic *Pfiesteria* complex as causative agents of the field fish kill or disease event. Alternatively, if sufficient cell densities are observed, we take fresh samples (unpreserved or unpoisoned) from the same area(s) into tests (laboratory bioassays) with live fish. If *Pfiesteria*-like species become abundant (usually within several days) and the fish begin to die, we record the data as a "positive" for the toxic *Pfiesteria* complex. If not, we rule out the toxic *Pfiesteria* complex as causative agents of the kill or disease event. These two

steps are designed to show (i) whether *Pfiesteria*-like species were present at potentially toxic levels, and (ii) whether they were, in fact, actively toxic toward fish. That is, this step is important to determine whether toxic *Pfiesteria*-like species were present, since these dinoflagellates are also known to have many nontoxic stages that make their living as little microbial predators.⁹

If toxic *Pfiesteria*-like dinoflagellates are confirmed as both present and active, we continue to allow the toxic population to grow by sacrificing more fish to it, and eventually build high enough cell densities to sample for use in another technique. (iii) In the third step of this process, we identify which *Pfiesteria*-like species is/are present. The 4-6 outer membranes that wrap around each tiny dinoflagellate cell must be carefully stripped away with mild detergent and/or alcohol, leaving small deposits of cellulose (called "plates") exposed to view¹⁰. The number and arrangement of these plates must be determined, from both top/bottom and front/back views of the cells, to make a final identification.

Toxic bioassays with test fish must be completed in biohazard III facilities, conforming with state and federal guidelines for protecting human health when working with *Pfiesteria* and its close allies. Although it is sometimes possible to encourage *Pfiesteria piscicida* and other *Pfiesteria*-like species to grow by offering them certain types of algae to eat, the old adage, "To catch a tiger, do not set a trap for a rabbit" may apply here. That is, offering algae in an attempt to detect *Pfiesteria*-like species that were present at a fish kill does not work with certainty because algal prey stimulate growth of nontoxic forms and species. Toxic *Pfiesteria piscicida* that has been feeding on dying fish sometimes takes a fairly long time (weeks) to "change over" to a diet of algae. If the question is, "Were nontoxic *Pfiesteria*-like species present?," then algal prey can be offered to the sample from a field site. But not all *Pfiesteria* lookalikes appear to be capable of toxin production. If the question is, "Were toxic species present?," then one should work with toxic stages -- and that requires adding fish to field samples while in proper facilities to ensure human health safety. It is recommended that the "algae" method be rigorously compared to the "fish" method before it can be relied upon in work to identify species of toxic *Pfiesteria*-like dinoflagellates that were present and active at fish kills and disease events.

Nutrient Stimulation of Toxic *Pfiesteria*-Like Dinoflagellates

We are working to characterize the substances in fish secreta/excreta that stimulate toxic *Pfiesteria*-like dinoflagellates to become lethal to fish. But, another important question remains: How do these dinoflagellates make their living when fish are not available? This question is important to understand influences of other nutrient conditions in controlling the growth and survival of *Pfiesteria*-like species. In ongoing research, we have examined the effects of nutrient enrichment on nontoxic zoospores (an active, swimming stage) of *Pfiesteria*-like dinoflagellates through a combination of field observations and laboratory/field experiments. These experiments have been designed to mimic the potential effects of nutrient loading by human-derived sources such as sewage, agricultural wastes, and urban runoff.

Our experimental research has shown that these dinoflagellates are actually animals, but they can "adopt" plant-like photosynthesis by consuming algae (which are microscopic, primitive plants) and retaining their photosynthetic biochemical machinery (contained in small structures called "kleptochloroplasts")⁵. Other prey that *Pfiesteria*-like dinoflagellates consume span all trophic levels (bacteria, small animals, fish, and mammalian tissues). Hence, their nutrition is complex and

cannot be expected to directly parallel the linear response of algae to nutrient enrichments. Our extensive laboratory and field information repeatedly has demonstrated that the response of *Pfiesteria piscicida* and other *Pfiesteria*-like species to nutrient enrichments depends on (i) prey type and availability; (ii) history of feeding (some prey are more enriched than others); (iii) nutrient form and abundance; and (iv) season^{5,11}. In the absence of abundant fish prey, and under conducive conditions (especially warm temperatures and calm waters), *Pfiesteria*-like dinoflagellates can be strongly stimulated by both organic and inorganic forms of nitrogen and phosphorus, directly and/or indirectly as mediated by the abundance of algal prey.

In other field research we have found significantly higher abundances of *Pfiesteria*-like zoospores near municipal wastewater discharge sites in calm waters, relative to control sites⁵. Cell densities of these dinoflagellates in sewage areas have been strongly positively correlated with both algal prey densities and total phosphorus concentration. We documented an apparent positive response of toxic *Pfiesteria*-like species to a major swine effluent lagoon discharge, as well¹². A long-term field study in the mesohaline Neuse Estuary of North Carolina also has demonstrated a significant positive correlation between *Pfiesteria*-like zoospore densities and phytoplankton abundance during spring seasons that are preceded by high-precipitation winters⁵. Such conditions impart high nitrogen and phosphorus loading from the precipitation and runoff, which is known to support massive late winter-spring nontoxic dinoflagellate blooms. In part the positive relationship we have established between *Pfiesteria*-like species and late winter dinoflagellate blooms on the Neuse Estuary is attributed to the fact that these blooms include a certain species of algae that we have identified as a preferred food source for *Pfiesteria*, prior to arrival of large schools of Atlantic menhaden and other fish later in the growing season. Overall, our data thus far indicate that *Pfiesteria*-like species respond best to degraded water quality from nutrient over-enrichment, because excessive nutrient loadings help to create an environment rich in microbial prey and dissolved organic materials that these dinoflagellates use as food when fish are not abundant in the immediate area⁵.

Beyond Fish: Initial Linkages Between the Toxic *Pfiesteria* Complex and Human Health

Strong evidence from a laboratory setting implicates the representative species, *Pfiesteria piscicida*, in serious effects on human health¹³. This information is summarized from a peer-reviewed publication in an international science journal, co-authored by the medical specialist who has worked most intensively to characterize the cases of laboratory exposure¹³. Ten people have been impacted thus far, including three seriously affected, when in proximity to toxic cultures. These scientists worked in five different laboratories. Although the toxins from these dinoflagellates have not yet been fully characterized, the time-locking of the symptomatology convinced the laboratory staff and medical counsel (Duke Medical Center, Durham, NC) of the linkage to organic toxin exposure from the fish-killing cultures. Effects have occurred after either direct contact with culture water or, more frequently, by inhaling aerosolized toxins from the cultures. The three people who were most seriously affected each worked with toxic cultures containing cell concentrations that are within the range found at fish kills in the wild) for 1-2 hours per day, over 5-6 week-periods. The cultures consisted of several small aquaria (2.5 - 10 gallon) containing fish-killing culture of *Pfiesteria piscicida*, within standard laboratory rooms (usually ca. 250 square feet or larger). In one case the aquaria were loosely covered; in the other two cases the aquaria were tightly

covered except for a 15-minute period in the morning, afternoon, and evening when dead fish were replaced with live fish to induce the cultures to continue to produce toxins.

Although most symptoms developed in the three most seriously affected laboratory workers after the 5-6 week-period, some symptoms (in one or more cases: sporadic inability to remember conversations, sudden extreme irritability, burning eyes, difficulty breathing, and development of several "mysterious" sores that responded poorly to treatment with antibiotics) did manifest earlier but were attributed to stress, viral infections, allergies, and other unrelated causes. More pronounced symptoms ranged from narcosis, eye irritation, erratic respiratory distress, stomach cramping and vomiting (initial effects) to development of larger epidermal lesions, severe headache, learning disabilities (serious cognitive impairment), and Alzheimer's-like short-term memory loss (effects that sometimes have lasted for weeks to months)¹³. These symptoms mostly reversed in the laboratory workers following cessation of contact with toxic cultures. However, some symptoms have recurred as an ongoing problem, thus far, for six years following exposure as "relapsed" effects, especially following strenuous exercise. Compromised immune system and peripheral nervous system dysfunction have been associated as more long-term impacts (years). The remaining seven people who reported symptoms during or following work with toxic cultures sustained incidental or milder short-term exposure¹³. Their symptoms generally were limited to eye and/or skin irritation, sore throat, mild respiratory difficulty, and mild to severe headache. In most of the seven cases, the route of exposure apparently was inhalation of neurotoxic aerosols from the fish-killing cultures, with limited water contact also involved in two cases.

During 1996, controlled experimental research conducted with colleagues at Duke University has shown that subcutaneous injection of toxic culture that was previously frozen promotes significant cognitive impairment as short-term memory loss and sustained learning disabilities in rats, relative to control animals that were injected with similar aquarium water which did not contain *Pfiesteria piscicida*. This information has been peer-reviewed and is in press within an international science journal¹⁴.

In North Carolina's estuaries, anecdotal information from fishermen, docksmen, and other people who have frequented known sites of repeated toxic activity by *Pfiesteria piscicida* and at least one other toxic *Pfiesteria*-like species has indicated the potential for these dinoflagellates to adversely affect human health in natural habitats. Exposure to waters that were found to contain sublethal populations (to fish: manifested by ulcerative bleeding-sore diseases in fish) or lethal populations of these dinoflagellates (manifested by fish kills that have sometimes lasted up to six weeks) has been correlated with health complaints by local citizens. A second route of exposure appears to be aerosols from waters containing active toxic *Pfiesteria*-like dinoflagellates. Reported symptoms have included epidermal lesions that do not respond well to antibiotics and require long periods to heal, sporadic memory loss and disorientation, eye irritation, tingling sensation in parts of the body that are immersed into the water, and chronic respiratory infections. Frequently, such reports have described a lessening or disappearance of the symptoms following weeks or months without visits to the affected estuarine areas. The extent to which these cases can be related to, vs. eliminated, as related to toxic *Pfiesteria*-like dinoflagellates has not been determined.

Similar health problems were reported by watermen, their families, state workers, and some recreationists who fished, sampled, or otherwise contacted waters in the Pocomoke Estuary, Maryland, during fish disease and fish kill events that have been linked to toxic *Pfiesteria*-like

dinoflagellates (as indicated by bioassays with test fish in biohazard III facilities, followed by identification procedures with scanning electron microscopy)¹⁵. An extensive evaluation involving a team of medical researchers, local physicians, local and state health departments, the CDC, NIEHS' intramural program, and others recently culminated in a report that has related certain human health impacts in some of these cases to exposure to active, toxic *Pfiesteria*-like species that were linked to either fish disease or fish death¹⁵. Most notable in these human cases were profound learning and memory disabilities, associated with water contact and/or inhalation of aerosols from the water in the affected area. Much more work is needed to develop improved diagnostic tools, including specific tests for toxins and more subtle but potentially serious influences, to examine the extent to which these dinoflagellates may otherwise impact the health of watermen and other frequent users of affected estuaries.

Thus far, there is no evidence to support a potential third route of human exposure to the toxins from *Pfiesteria* and its close allies, namely, consumption of fish from affected areas. The toxins from these organisms are known to be highly lethal to fish (see information below), so that fish appear to develop erratic behavior, open sores, peeling skin, hemorrhaging, and/or other obvious symptoms after low toxin exposure^{4,5}. Fish with such appearance likely would not be marketed, and they should be avoided for consumption whether from a toxic outbreak area of *Pfiesteria*-like species or not. Other encouraging information is indicated by repeated instances in which gulls and other wildlife have been observed to consume large quantities of dying fish in disease and kill events that have been related to these toxic dinoflagellates, without apparent adverse health impacts. Research is underway in collaboration between our laboratory and the U.S. Food and Drug Administration to determine more about food safety issues related to the toxic *Pfiesteria* complex.

Little is yet known about the toxins produced by *Pfiesteria piscicida* and other toxic *Pfiesteria*-like dinoflagellates, except that at least one major toxin component from *Pfiesteria piscicida* is water-soluble and another is highly lipophilic (soluble in fatty materials). These components or fractions are known to be denatured in filtered or unfiltered estuarine water within 3-24 hours. Until the toxins are identified, and without carefully designed accompanying epidemiology studies that include clinical and neuropsychological testing, many questions about the potential for these dinoflagellates to cause health impacts for local human populations will not be possible to resolve. However, within the past two months we have begun to make substantial progress in toxin characterization. The lipid-soluble fraction of these toxins has been observed to destroy fish epidermis and the ability of fish to osmoregulate. With help from colleagues at the National Marine Fisheries Service - Charleston's Marine Biotoxins Center, and the NIEHS Intramural Program, a major toxin in the water-soluble fraction has been isolated and purified; test fish that are exposed to it become moribund in 2-3 seconds, with death following in 3-5 minutes. Thus far this water-soluble component has been heat-stable, and can retain lethal activity toward fish after being heated for 2 hours at 175°F. We are also working with these colleagues to develop a test that will enable us to quickly detect very low levels of this toxin in water samples from fish kill and disease sites in both natural habitats and aquaculture facilities¹⁶.

Future Directions

For Congress to most effectively guide future research on toxic *Pfiesteria*-like dinoflagellates, an old adage applies: Wise direction on where we need to go demands an understanding of where we have been. For the past seven years since we first tracked *Pfiesteria piscicida* to massive fish kills in

the Albemarle-Pamlico Estuary, my colleagues and I have struggled to bring this issue to public attention so that it can be addressed, in order to strengthen protection of fishery resources and public health. Because the biology of these dinoflagellates -- with their fascinating complex life cycles and their apparent, deliberate attack behavior toward fish -- is so unique, we were met for some time with healthy skepticism on the part of many of our scientific colleagues. But this research, with linkages to nutrient pollution and human health impacts, also crosses certain political and economic lines. For many years we have encountered resistance from special interests who refused to accept the possibility of *Pfiesteria* stimulation by nutrient enrichment. I believe that some local officials and special interests have influenced some scientists who are inexperienced in working with *Pfiesteria*-like species. I am troubled by scientists who have publicly stated that they intend to disprove all aspects of our research -- thus revealing a bias that extends beyond objective "healthy scientific skepticism" to other motivation. Fortunately for the science but tragically for those who have been hurt both physically and economically, Maryland state officials have made significant progress in advancing our understanding of the public health problems posed by these organisms. Such progress was made, in part, because state environmental and health officials, following a directive of Maryland's Governor, reached out for guidance to many scientists including our laboratory, and developed collaborations of interdisciplinary teams who directed their expertise toward a thorough examination of fish disease and factors related to it in a river that was affected by an outbreak of the toxic *Pfiesteria* complex.

The reality "from the trenches" of *Pfiesteria* research, over the past seven years since we first tracked *Pfiesteria piscicida* to a major fish kill, has been as follows. We have devoted many of our efforts to monitoring programs and to mass-culturing *Pfiesteria*-like species so that sufficient quantities of the toxins from these organisms can be produced for analysis and identification. This information is critically needed before we can determine, for certain, whether fish from toxic outbreak areas are safe for human consumption, or the extent to which people are being hurt from *Pfiesteria*-like species in our coastal waters. The task of mass-culturing *Pfiesteria*, alone, requires attention seven days per week, 24 hours per day, by two highly trained people working full time on a "buddy" system because of safety mandates. We sacrifice nearly 100 small fish per day to stimulate these dinoflagellates to make toxins that we have shipped to various colleagues for analysis and research (in five different state, university, and federal laboratories). Safety protocols must be strictly followed for this work. The research with all toxic cultures, from North Carolina, Delaware, Maryland, Virginia, New Jersey, South Carolina, Florida, and other areas of the Gulf Coast, must be done in isolated, quarantined, limited-access biohazard III facilities in accord with federal and state mandates. The cost of disposable safety materials -- gloves, boots hair covers, respirators, air filters -- is nearly \$40,000 per year for culture maintenance, alone. All technical support for this work has come, and continues to be supported, from small grants which -- because of the expense involved just to grow the organisms -- have left very little funding for research.

Our biohazard III facility actually is a retrofitted single-wide trailer without a backup generator for emergency power, and frequent power outages during storm events that have caused setbacks of dormant culture and much time lost. Nearly all of what is known about *Pfiesteria*-like dinoflagellates has been accomplished in this limited facility. Under these conditions we have continued to make progress in determining answers about *Pfiesteria*'s distribution, its impacts on fisheries, and its threat to human health in that facility. While our insights have advanced, I regret that we do not have more progress to report because we are hampered by inadequate space and funding.

Apart from mass-culturing these dinoflagellates for toxin analysis, most of the work that we have done and continue to do is for coastal states who have requested our help in monitoring for *Pfiesteria*-like species; our priority, like yours, is protecting public health. Funding thus far from state or federal sources for these efforts has not been forthcoming, though some reimbursement is promised. This work has included helping to safeguard children's camps in areas prone to outbreaks by the toxic *Pfiesteria* complex; sampling to safeguard recreational areas where toxic outbreaks have occurred; and sampling to help watermen determine whether their fishing areas are temporarily free from toxic *Pfiesteria*-like dinoflagellates. We were engaged in these efforts long before this issue developed a national profile attracting the attention of the White House, concerned members of Congress, federal agencies, and other states, and we are committed to continue to do all that we can to contribute our expertise toward strengthening protection of coastal resources and public health.

We have forged collaborations with many Federal agencies including the National Marine Fisheries Service - Charleston's Marine Biotoxins Center, the NIEHS intramural and extramural programs, the Food and Drug Administration, the U.S. Environmental Protection Agency, and (planned) the U.S. Geological Survey. We have also developed strong collaborations with various state agencies as mentioned (North Carolina, Maryland, Delaware, New Jersey, Virginia, Florida, Alabama). We have worked intensively to help these states detect toxic *Pfiesteria*-like species in order to provide early warning systems to protect human health insofar as possible, given the present status of our knowledge. And, we have ongoing collaborations with many researchers from universities in New England, the mid-Atlantic, and the Southeast, bringing an interdisciplinary team effort to bear in resolving some of the most important questions about the toxic *Pfiesteria* complex in issues of fish resource viability, coastal water pollution control, and human health protection. With these collaborations, strengthened by our foundation of nearly a decade of expertise from intensive research on *Pfiesteria*-like species, our research laboratory at North Carolina State University spans all aspects of the "*Pfiesteria* issue:" fundamental understanding of the life histories and many appearances of these complex, dangerous organisms; their reliable detection at fish kills and disease events in estuaries and aquaculture facilities; their toxins; and the impacts of these toxins on estuarine ecosystems, fishery resources, marine mammals, and humans.

How does Congress best enhance efficient progress in our ability to understand *Pfiesteria* and its close allies, to mitigate their damage and discourage their growth? ... I believe that this can be best achieved by funding several major laboratories to serve as centers of coordinated, multi-disciplinary research efforts. To optimize progress, senior scientists in these facilities should have expertise on *Pfiesteria*-like species, which are unique among harmful microorganisms in many respects (for example, their complex life cycles, their complex behavior in chemically sensing fish and other prey, their aerosolized suites of toxins). This expertise should be demonstrated by the scientific yardstick of peer-reviewed, international publications on the toxic *Pfiesteria* complex in the science literature. These experts should help to train scientists from other states and regions. Solid science can be ensured by supporting healthy competition, as well -- which, in the scientific community, encompasses corroboration and cross-comparison of the work by independent laboratories across regions -- on all of the *Pfiesteria*-like species.

A second point should be emphasized here. The biology of *Pfiesteria*-like species has captured the imagination of citizens of all ages. I have presented information on *Pfiesteria*, and its linkages to both fishery resources and water quality declines, in many public forums with audiences ranging from elementary school children to retirees. I would envision centers for research of this

type be designed to also provide opportunities for environmental education outreach. Partnerships with environmental education programs are critical to improving the public understanding on the effects of coastal pollution.

Federal support is critically needed for our multi-investigator, interdisciplinary research in the U.S. mainland's second largest estuary, the Albemarle-Pamlico -- where more than a billion fish have died from *Pfiesteria*-like species which have struck each year at least since 1991 -- and comparative research support for the mainland's largest estuary, Chesapeake Bay, which is now also known to sustain toxic outbreaks by these dinoflagellates. Although impacts on fish and human health in the Chesapeake and Albemarle-Pamlico appear similar, these species may vary with differences in background environmental conditions from region to region, for example, in the types and relative proportions of toxins they produce, and in their response to environmental factors such as nutrient pollution. As other areas may develop toxic *Pfiesteria*-related fish kills and disease, additional funding support would be needed, and is already needed for massive problems that these areas face from other harmful microorganisms affecting coastal waters (for example, the toxic dinoflagellate, *Gymnodinium breve* in Florida). Federal support of our research efforts, in the collaborations that we have forged, would meet an identified need of this Congressional subcommittee to maximize effectiveness in utilizing funding resources to strengthen our understanding of these marine organisms, and to reduce their serious impacts on fisheries and humans.

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TESTIMONY

by

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Subject: *Pfiesteria piscicida*

My name is Lynn Donelson Wright and I am Dean and Director of the Virginia Institute of Marine Science of The College of William and Mary. The Virginia Institute of Marine Science, School of Marine Science (VIMS/SMS) was established in 1940, as the Virginia Fisheries Laboratory. The Virginia Institute of Marine Science has as its mission research, education, and advisory service to support the needs of the Commonwealth of Virginia and the Nation. The emphasis is on interdisciplinary coastal and estuarine marine science. In a society that is increasing its pressure on the environment and natural resources, the coastal ocean and estuarine environment is a region of vital concern. The Institute's central purpose is to provide sound, objective scientific knowledge and advice in support of management and policy as applied to the marine resources of the Commonwealth of Virginia specifically and the coastal ocean generally. It is internationally and nationally recognized as an unbiased source of objective scientific advice, and it is respected by government, industry and the general public for the quality of that expertise.

Among its many research activities, the Institute is presently serving as a member of the Virginia *Pfiesteria* Task Force and is actively engaged in research aimed at improving understanding of this enigmatic organism as quickly as possible within the constraints imposed by accepted scientific rigor. The group of VIMS scientists most actively engaged in *Pfiesteria*-related research include Drs. Eugene Bureson, Leonard Haas and Wolfgang Vogelbein. VIMS has a multi-faceted involvement in *Pfiesteria*-related research. However, it must be emphasized at the outset that research on *Pfiesteria*-like organisms is characterized more by what we don't know than by what we do know. Much information inferred from field observations has not yet been verified or firmly established by careful laboratory studies. There is a critical need for research on a wide variety of topics related to *Pfiesteria* and other *Pfiesteria*-like organisms.

What is VIMS currently doing in regard to *Pfiesteria*?

1. VIMS conducts monthly trawl and seine surveys in Virginia waters. Since August, the surveys have been conducted weekly in the Pocomoke River. Additional stations have been monitored in the Rappahannock River. These surveys document the temporal and spatial occurrence of lesions in Virginia.
2. VIMS has established a Web site to provide public access to a fact sheet on *Pfiesteria*, the Task Force, periodic updates released by the Virginia Health Department and links to other web sites with information on *Pfiesteria*.

3. VIMS scientists are developing protocols for identifying *Pfiesteria*-like organisms using scanning electron microscopy.

4. VIMS scientists are culturing non-toxic stages of *Pfiesteria*-like organisms in the laboratory in preparation for experimental studies.

What is *Pfiesteria*?

Pfiesteria piscicida is not a virus or bacterium and it is not an infectious agent; fish or other organisms cannot become infected with *Pfiesteria*. *Pfiesteria piscicida* is a dinoflagellate, a microscopic, free-floating, single-celled organism with two flagella for locomotion. Most dinoflagellates are plants (called algae or phytoplankton) that gain energy from photosynthesis. However, many species of dinoflagellates, including *Pfiesteria*, do not photosynthesize, but behave like animals and consume algae or bits of organic matter. Normally, *Pfiesteria* feeds on algae cells.

Identification of *Pfiesteria*-like organisms is extremely difficult and can be accomplished with certainty only with the use of a scanning electron microscope. Light microscopy is unreliable and has led to much confusion concerning the actual species present during fish kills. It is now recognized that there are at least two distinct species in the *Pfiesteria*-like complex of organisms.

What causes *Pfiesteria* and other *Pfiesteria*-like organisms to become toxic?

The conditions that trigger the transformation from a non-toxic to a toxic stage are not well understood, but it seems to occur only in the presence of fish. The toxin can cause sloughing of the surface layer of fish skin and, in high concentrations, can kill fish. *Pfiesteria*-like organisms have been implicated as the causative agent of fish lesions along the East Coast and of fish kills in North Carolina and in the Pocomoke River near the Virginia/Maryland border on the Eastern Shore.

In order for *Pfiesteria*-like organisms to kill fish, hydrographic conditions must allow them to sense fish in the water column and concentrate the toxin. These conditions occur in shallow, poorly flushed systems.

Does *Pfiesteria* occur in the Chesapeake Bay?

Pfiesteria piscicida has not definitely been confirmed from the Chesapeake Bay. However, other *Pfiesteria*-like toxic dinoflagellates are known to occur from the Gulf of Mexico along the East Coast as far north as Delaware Bay. An undescribed *Pfiesteria*-like organism has

been reported in Virginia waters near the mouth of the Pocomoke River and it is known to occur in Maryland. *Pfiesteria*-like toxic dinoflagellates probably occur all along the East Coast in low numbers.

Are there other possible causes of lesions (open sores) on fish?

There are many possible causes for fish lesions including physical injury in nets or traps, bites by other fish or birds, toxic chemicals, and diseases such as viruses and bacteria. On the basis of laboratory experiments, we now have to add toxins released by *Pfiesteria* to the list of possible causes. The present state of scientific knowledge is usually insufficient to allow determination of the original cause of a lesion unless an obvious parasite is present.

Have there been unusually high numbers of fish lesions during 1997?

Some fish lesions occur every summer in the Chesapeake Bay. However, based on information from the Virginia Marine Resources Commission, the Department of Environmental Quality and the Virginia Institute of Marine Science and also from agencies in Maryland, the incidence of lesions on Chesapeake Bay fish during 1997 is not unusually high and there is no indication that fish populations are facing serious problems.

Lesions on juvenile menhaden were first noticed along the East Coast from Delaware Bay to Florida in the fall of 1984. Much research was conducted on this problem in many states, but no conclusive causes were identified. Similar lesions have been observed every fall since 1984 in Chesapeake Bay. *Pfiesteria* or *Pfiesteria*-like organisms are now suspected as the cause of these lesions, but no direct cause and effect relationship has been firmly established in laboratory studies.

The Pocomoke River, located on the Eastern Shore near the Virginia-Maryland border, may be an area where an unusually high number of fish lesions did occur during 1997. Commercial fishermen reported what they consider to be unusually high numbers of fish lesions in the Pocomoke River during the spring of 1997 and there were low- to moderate-level fish kills in the river during August. These lesions and kills have been linked to a *Pfiesteria*-like toxic dinoflagellate.

Have fish kills occurred in Chesapeake Bay in the past?

Small- to moderate-scale fish kills, usually of small menhaden, occur occasionally in tidal creeks during the summer months. These kills are usually caused by low oxygen content of the water, but other possible causes, now including *Pfiesteria*, are routinely investigated.

Can Chesapeake Bay expect large-scale fish kills similar to North Carolina?

When fish with lesions were first observed in the Pocomoke River there was doubt

about the possible role of *Pfiesteria*-like organisms as a cause because of the lack of large numbers of dead fish on the surface. In North Carolina, where *Pfiesteria* has been reported to be the cause of fish kills, there are reports of large numbers of dead fish, often hundreds of thousands to millions, during fish kills. Recent fish kills in the Pocomoke River, attributable to *Pfiesteria*, report thousands to perhaps tens of thousands of dead fish, much lower numbers than observed in North Carolina.

One possible explanation for the fewer numbers of dead fish in the Chesapeake Bay region as a result of *Pfiesteria* may be differences in hydrography between these two regions. The Pamlico Sound and Nuese River estuary in North Carolina are very shallow, poorly flushed estuaries with weak tidal currents. By contrast, the Chesapeake Bay and its tributaries are typically deeper, better flushed and have stronger tidal currents. It is possible that the greater the dispersion of these chemical cues and toxins by water currents and circulation, the fewer fish will be detected and killed. Also, in deeper water fish may be less concentrated.

Is it safe to eat Virginia seafood?

YES, Chesapeake Bay seafood is safe. As is always the case with seafood, fishermen and consumers should use common sense. Fishermen should not harvest dead fish and consumers should avoid fish with sores. Otherwise there is no reason to avoid eating Virginia seafood. There have been no reports of adverse effects on human health from eating shellfish (crabs, oysters, etc.) harvested in the vicinity of fish kills, but little information is available on this subject. VIMS is investigating this question.

Does *Pfiesteria* affect humans?

A variety of symptoms have been reported by commercial watermen and other citizens in North Carolina, Maryland and Virginia and by researchers who cultured *Pfiesteria* in the laboratory. Symptoms, including sores, fatigue and short-term memory loss, have been associated with laboratory exposure, or with large-scale fish kills in North Carolina and with fish kills in the Pocomoke River in Maryland and Virginia. Portions of the Pocomoke River were closed periodically during August because of possible human health concerns.

Is *Pfiesteria* related to red tides?

Pfiesteria is a dinoflagellate and red tides are typically, but not always, caused by dinoflagellates. *Pfiesteria* is known to be toxic to fish and red tides are often, but not always, toxic to marine life. Despite these similarities, there are important distinctions to be made between *Pfiesteria* and red tides, especially for the Chesapeake Bay region. *Pfiesteria* is reported to kill fish when it occurs at low concentrations in the water. This is not a sufficient concentration of cells to discolor the water and *Pfiesteria* has never been reported to cause discolored water.

Red tides (also called red water or mahogany water) are typically caused by the dense accumulation, typically thousands of cells per milliliter of water, of dinoflagellates near the surface. Red tides are common occurrences in the Chesapeake Bay and its tributaries. They can occur at any time of year but usually are most common during July and August. Unlike other coastal regions of the United States where red tides result in fish death and bans on eating shellfish, red tides in the Chesapeake Bay to date have not been toxic to marine life. This lack of toxicity is because the species of dinoflagellates causing red tides in Chesapeake Bay are not toxic species. Some species that cause red tides in other regions are toxic. Red tides are typically categorized as a type of Harmful Algal Bloom (HAB), whether they are harmful to aquatic life or not. There is increasing interest in HABs worldwide because of the perception that they are becoming much more numerous, are often toxic to marine life, and are likely caused by man's influence on coastal areas.

What ocean or estuarine conditions contribute to increased abundance of *Pfiesteria*-like organisms?

It is hypothesized that nutrient enrichment of estuaries and coastal waters from a variety of land-derived sources is a cause of proliferation and activity of *Pfiesteria*-like organisms. Some scientific literature supports this. The association between *Pfiesteria* and nutrient enrichment is also fostered by the tendency to associate *Pfiesteria* with algal blooms, which are well documented to result, in part, from nutrient enrichment of natural waters. However, as discussed above, *Pfiesteria* is not an algae. It does not make its own food by photosynthesis and does not require dissolved nitrogen and phosphorous (two typical nutrients) in the water for its nutrition. *Pfiesteria* eats other microscopic plants and animals. Because it is an animal and not a plant it is less likely to respond directly to nutrient enrichment. To the extent that its preferred food is microscopic algae, one might expect *Pfiesteria* to be more abundant where its preferred food is more abundant. Thus, it might be indirectly linked to nutrient enrichment through its food supply.

In general, the Chesapeake Bay and its tributaries are not as enriched with nutrients as the Pamlico Sound and its tributaries in North Carolina. Nevertheless, *Pfiesteria*-like organisms have been reported from various locations in the Chesapeake Bay and have been linked to fish kills and human health problems in the Pocomoke River even though that River is not considered to be highly nutrient enriched. Other, more enriched areas of the Bay have not experienced fish kills or fish with lesions. The carefully controlled scientific experiments which identify nutrient enrichment as a stimulus to *Pfiesteria*-like organisms are few and others are currently being conducted. Until more results are available, it is not possible to say with confidence why *Pfiesteria*-like organisms occur and why they become toxic. Thus, it is difficult to predict outbreaks of these organisms.

How can Federal funding be effectively utilized to study toxic dinoflagellates?

Some Federal funding should be provided to universities in individual states for the

development of centers of excellence for research on *Pfiesteria*-like organisms; however, much the funding should be placed in new or existing competitive grant programs. There are four primary areas of research that are important for a full understanding of the biology of toxic dinoflagellates and their effects on fish and shellfish and on humans.

1. Rapid identification methods. At least two (and probably more) species of tox heterotrophic dinoflagellates are recognized in what is now referred to as the *Pfiesteria* complex or *Pfiesteria*-like species. At the present time, these species can be identified only with the aid of a scanning electron microscope and there is only one laboratory in the United States that present has the expertise to identify these organisms (Florida Marine Research Institute). The capability for scanning electron microscope identification must be acquired by other states through training workshops. However, it is also critical that rapid, sensitive, state of the art molecular or immunological diagnostic techniques be developed for these organisms. This will eliminate the tedious and time consuming electron microscopy for routine diagnosis and will greatly improve the ability to rapidly identify *Pfiesteria*-like organisms in water samples. The studies listed below will have to be completed for each species identified.

2. General biology and nutritional ecology of *Pfiesteria*-like organisms. The general biology of *Pfiesteria*-like organisms is poorly understood. A number of different life cycle stages have been reported for *Pfiesteria piscicida*, but the factors that trigger transformation from one stage to another are not understood and it is not known if other similar species have similar life cycle stages. Basic environmental tolerance to temperature, salinity and pH are not known for most *Pfiesteria*-like organisms. Of particular importance is the nutritional ecology of *Pfiesteria*-like organisms. On the basis of field observations in North Carolina, a link has been suggested between degraded water quality and abundance of *Pfiesteria*-like organisms. However, this relationship has not been well established in laboratory studies and the association remains speculative at best. Careful laboratory studies are critically needed to establish this relationship with certainty, including studies to examine the relationship between abundance of *Pfiesteria*-like organisms and organic and inorganic nutrient enrichment.

3. Toxin characterization and toxicity studies. Each species in the *Pfiesteria* complex probably has a different toxin. It is critical that these be purified and characterized so that their mode of action can be determined and so that rapid detection tests can be developed to allow measurement of toxin levels in the water and in tissues of aquatic organisms. Purification and characterization of the toxin will also allow research studies on the effect of toxins on marine organisms. For example, although it is known that *Pfiesteria* toxins can cause degradation of the skin of fishes, the relationship between *Pfiesteria*-like toxins and lesions on fish is poorly understood and there is not at present a definitive *Pfiesteria* lesion that can be identified. Careful laboratory studies are needed to determine the relationship between *Pfiesteria*-like organisms and fish lesions with certainty. This relationship may vary among the various species in the *Pfiesteria* complex. The conditions under which *Pfiesteria*-like organisms transform from a non-toxic to a toxic state are poorly understood. Toxin production seems to require the presence of fish, but other factors, including hydrodynamics, are undoubtedly important. A thorough study of these

factors is necessary to identify areas where *Pfiesteria*-like organisms are likely to occur. Similarly, human health effects from *Pfiesteria*-like organisms are poorly understood, but could be investigated if toxins were purified and characterized.

4. Epidemiology. Understanding the spatial and temporal distribution of lesions on juvenile menhaden and other fishes in relation to abundance of *Pfiesteria*-like organisms is critical to a full understanding of the problem. Analyses of spatial and temporal patterns of lesion abundance in relation to salinity, nutrient levels and other environmental parameters will allow formulation of hypotheses on controlling factors that can then be examined in laboratory or studies. In addition, such studies may allow development of an early warning system for *Pfiesteria* outbreaks.

Because of extensive studies along the entire southeastern coast of the U. S. during the menhaden lesion problem of the mid 1980s, some historical data are available that can be used to examine the relationship between fish lesion/*Pfiesteria* abundance and long-term climatic effects.

MARYLAND DEPARTMENT OF NATURAL RESOURCES
 SECRETARY JOHN R. GRIFFIN
 TESTIMONY BEFORE HOUSE SUBCOMMITTEE ON
 FISHERIES CONSERVATION, WILDLIFE AND OCEANS COMMITTEE ON RESOURCES
 THURSDAY, OCTOBER 9, 1997 -- 10:00 AM

Thank you, Mr. Chairman for inviting me to talk with you about how Maryland is addressing the ongoing problem of *Pfiesteria*. Let me also take this opportunity to say that all of us in the State are very grateful for your actions, and the critical support we have been receiving at the federal level.

Right now, Maryland is facing an unprecedented challenge to the health and vitality of our waterways and our citizens. As most of you know, in recent weeks three Eastern Shore waterways -- the Pocomoke River, a creek of the Manokin River watershed, and a section of the Chicamacomico River -- have all experienced outbreaks of toxic *Pfiesteria*-like organisms.

Pfiesteria and *Pfiesteria*-like organisms are not only threatening our Bay tributaries and their watersheds, they are also having a dramatic impact on the lives of Maryland's citizens and visitors. Our farmers, our anglers, our fish merchants and our hospitality businesses are all being affected to some degree.

Although Maryland was the first state in the nation to link toxic outbreaks of *Pfiesteria* to concerns about public health, we are not alone in our experience with this problem: Delaware experienced a massive fish kill in 1987 that may have been be *Pfiesteria*-related; *Pfiesteria*-like organisms have been found in Virginia's Rappahannock River; and North Carolina has been struggling with this problem for more than six years. *Pfiesteria* knows no geographic boundaries.

Yet while other states have been challenged by *Pfiesteria*-like organisms, and Maryland has learned from them, our experience is somewhat unique. Indeed, while the Bay literally divides our State geographically, it is also a powerful unifying force in the lives of many Marylanders.

The Chesapeake Bay is much more than a body of water. The Bay and its tributaries support the region's economies, provide a wealth of recreational opportunities and are a significant component of our quality of life. One need only visit our State capital, Annapolis, to see just how true this is: *Treasure the Chesapeake* license plates abound. T-shirts, bumper stickers and calendars urge us to *Save the Bay*. Shops, restaurants and boating facilities proudly link their identity to our beloved Chesapeake Bay. As my boss, Governor Parris N. Glendening, said in his testimony to the Government Reform & Oversight Subcommittee on Human Resources last month, "Maryland is Maryland because of the Chesapeake Bay."

I am pleased to see that you have invited two of the people we have come to rely on most during this crisis, Dr. Don Boesch and Dr. JoAnn Burkholder, to address the science of this

issue -- the conditions that may be responsible for toxic outbreaks of this type of micro-organism, and our ability to predict, detect and manage them.

I know, however, that I speak for Governor Glendening and my counterparts at the Maryland Departments of Environment, Health, and Agriculture, when I say we have become far more expert on this subject than we had ever hoped need be.

Included as part of my written testimony is a chronology of our *Pfiesteria*-related activities to date that details what Maryland has done about *Pfiesteria* so far; what we plan to do about the this problem in the future; how the federal government is helping us now, and what they can do in the months ahead. Here, I would like to provide you with a brief summary of this information.

Maryland's response to occurrences in the Pocomoke, Manokin and Chicamacomico watersheds, has received national attention. When *Pfiesteria* first became a problem, Governor Glendening assembled an inter-agency team, led by the Secretaries of Agriculture, Health and Mental Hygiene, Environment and myself, to address this issue. Throughout our efforts to identify and understand this microbe, we have also been working with Maryland's academic and scientific institutions, as well as the Chesapeake Bay Foundation, the Watermen's Association, and renowned experts like Dr. Boesch, Dr. Burkholder and Dr. Karen Steidinger of Florida.

During this period, we have also been working closely with the people of Maryland. They are the ones who are feeling the economic impact of this problem; they are the ones whose quality of life has suddenly changed; and they are the ones whose health is being threatened.

For this reason, Governor Glendening has, with the full support of his cabinet and Maryland's local officials, insisted that the public has a right to know the same things we know. It is our hope that sharing information with the public has given the public confidence that we are doing the right thing in protecting public health.

While Maryland is working hard to accomplish several objectives, first and foremost is our responsibility to protect public health. Whether it is the consumers, the watermen or the recreational water enthusiasts, nothing is more important to us than the health and safety of our citizens.

The good news is that Maryland seafood is safe to eat. The seafood we buy at the grocery store and eat at restaurants does not come from affected waterways, and the Governor has implemented a statewide seafood marketing campaign to inform and reassure the public. Yet, while we know our seafood is safe to eat, we also know that toxic levels of *Pfiesteria*-like organisms are harming fish, and in some cases, are being linked to human health problems.

We received our first report of people becoming ill in April. At that time, the local public health officials, under the direction of Maryland's Department of Health and Mental Hygiene, encouraged anyone experiencing unusual illnesses to see their personal physician and to report their illnesses to the local health department. Since then, the State's medical team has continued to aggressively investigate the causes and effects of the presence of *Pfiesteria*-like organisms in Maryland's waters.

On August 6, we experienced our first major fish kill in the Pocomoke River, where as many as 15,000 fish were found dead or dying. We immediately issued a public health advisory to avoid all water contact in designated areas. When the fish kill continued, the Governor ordered an indefinite closure of the area and directed Natural Resources police to ensure compliance. Results from testing of water samples from the August 6 fish kill indicated the likely presence of *Pfiesteria*-like organisms.

On August 26, a fish kill occurred in the Virginia waters of Pocomoke Sound. We again issued an advisory to avoid water contact in nearby Maryland waters.

On August 29, the State's medical team, which included doctors from the University of Maryland, Johns Hopkins University, accompanied by the Centers for Disease Control and Prevention, presented the preliminary results of their evaluations of persons reporting illnesses thought to be associated with *Pfiesteria*. Their research has shown that people had suffered skin irritation, skin lesions, respiratory problems, as well as memory loss and other neurological problems.

As a result of this report, which found that persons exposed to the Pocomoke River during an outbreak of toxic *Pfiesteria* experienced difficulties in learning and short-term memory, on August 29, Governor Glendening ordered that the Lower Pocomoke River be closed. Although there was much discussion about closing the river on the Friday before Labor Day, Governor Glendening made the decision to move on the side of caution in consideration of public health.

Since June, the Departments of Natural Resources and the Environment have conducted an aggressive fish and water quality monitoring program, and evaluated point and non-point sources of pollution in affected and potentially affected areas. At the same time, our Agriculture Department has been reviewing farm practices in the Chesapeake watershed.

In addition to our primary focus of protecting the health of our citizens, we also are working hard to better understand *Pfiesteria*-like organisms, what causes them to become toxic and why they harm people and fish. Our scientists, health officials, water assessment teams and fishery biologists continue to grapple with the many pieces of this puzzle in order to form a complete picture of these outbreaks and what causes them -- causes that will almost certainly indicate a combination of both natural and man-made factors.

At this point, although we still probably have more questions than there are answers, we are extremely fortunate to have the nation's leading expert on *Pfiesteria*, Dr. JoAnn Burkholder, consulting with our research team.

In order to respond more effectively to this issue in Maryland, Governor Glendening broadened his action plan. Last month, the Governor created a Blue Ribbon Citizens Commission, chaired by former Governor and environmentalist Harry Hughes, to meet over the next several weeks and present recommendations by November 1, 1997, for implementing long-term objectives; approved a \$2 million emergency appropriation of State funds to help farmers plant the cover crops that help absorb unused crop nutrients; increased State monitoring and inspection of waterways that exhibit characteristics consistent with those in affected watersheds; and provided \$500,000 in State funds to educate the public on the safety of Maryland's seafood market and ensure the health and viability of this important industry.

As Maryland's war on *Pfiesteria* captured the national spotlight, surrounding states, as well as Congress and the Clinton Administration joined us in the fight to solve this problem. On September 19, Governor Glendening hosted a six-state summit on *Pfiesteria*. While each state is dealing with its own set of unique circumstances, the summit participants agreed to: establish a mechanism for exchanging information about *Pfiesteria* and how we can reduce the number of toxic incidents we are experiencing; provide for immediate notification of outbreaks and sharing of information needed to address the threat to public health threats; establish a regional technical team to work on reducing future outbreaks of toxic *Pfiesteria*; and, to work cooperatively in seeking a federal response to the human and environmental threats posed by *Pfiesteria*.

Last week our scientific and medical experts, finalized a new protocol for the closing and reopening of rivers affected by *Pfiesteria* or *Pfiesteria*-like events. I am pleased to note that in accordance with that protocol, Governor Glendening announced the reopening of the Pocomoke River on Friday, October 3.

At the federal level, the Governor has spoken personally with President Clinton, Vice President Gore, EPA Administrator Carol Browner and U.S. Secretary of Agriculture Dan Glickman, as well as members of our Congressional delegation, about the need for a coordinated federal response to a problem that is much bigger than the State of Maryland. We are deeply gratified at the rapid and comprehensive response they are preparing.

Senators Sarbanes and Mikulski and Congressmen Hoyer and Gilchrest, and the entire Maryland Congressional Delegation have all demonstrated incredible leadership on this issue. In response to our request, the White House quickly established an interagency working group to develop a coordinated response. Already, the federal government has provided \$500,000 in emergency assistance from EPA and NOAA. And an additional \$100,000 came from the U.S. Geological Survey.

Federally-supported experts have also been dispatched to help monitor water conditions, analyze data and investigate the health impacts of *Pfiesteria*. Working with state health officers from seven states, the Centers for Disease Control hosted a conference on *Pfiesteria* last week in Atlanta. We have also been assured that they are intensifying *Pfiesteria* research activities, and working with the Food and Drug Administration, the National Institutes for Environmental Health Sciences, USDA, EPA, NOAA, the U.S. Geological Survey, and the Fish and Wildlife Service. We are also hopeful that the millions of dollars of new money that the House of Representatives has already approved under the leadership of Congressmen Hoyer and Gilchrest, will be made available to CDC and NOAA to better understand the effects of *Pfiesteria*.

Very little national data or information exists on this toxic organism, and the research required is too massive for any one state to undertake on its own. Federal technical and financial assistance should be provided to citizens in affected and potentially affected areas to reduce incidents of future *Pfiesteria*-like outbreaks.

One area in which the federal government can play a critical role is expanding national research efforts to help provide our citizens, scientists and public health officials with a greater understanding of this organism. We must not only determine what causes outbreaks of *Pfiesteria*-like organisms in Maryland and elsewhere; we must also definitively determine what impact *Pfiesteria* is having on human health, our environment, and on our waterways.

Most urgently, we hope that the federal government will extend our State-only efforts to provide cover crop assistance to our farmers and to support our efforts to market Maryland seafood in view of recent outbreaks of toxic *Pfiesteria*.

We are presented with the challenge of assisting our seafood industry, which has suffered estimated losses of \$10 to \$15 million thus far this year. While some may argue that current disaster relief programs do not provide for such circumstances, one cannot argue that this has not been a natural disaster for the Marylanders whose livelihoods depend on a healthy, vibrant seafood industry.

We also ask that the federal government assist the states in developing improved nutrient management practices and innovative waste management methods, as well as continuing efforts to upgrade sewage treatment facilities.

Finally, we must work cooperatively to aid those farmers, watermen, poultry growers, and private citizens whose livelihoods have been adversely affected by recent outbreaks of toxic *Pfiesteria*. Specifically, federal technical and financial assistance should be joined with State researchers to help our citizens protect the public and environmental health of our State, as well as the livelihoods of those who live and work on the land and in the waters of Maryland.

In closing, I would like to offer a brief personal statement. One of the reasons I felt it

I am Secretary of Natural Resources in a state that is proud of its environmental record and works hard to be environmentally responsible. I am Secretary of Natural Resources in a state blessed with an incredible national treasure -- the Chesapeake Bay. I am also Secretary of a state whose citizens -- when they see a problem of this magnitude -- expect answers and deserve a solution.

Unable to provide our citizens with the answers they expect and the solutions they deserve, I have, since the beginning of the summer, traveled to the site of every toxic *Pfiesteria* outbreak in Maryland. I have seen thousands of lesioned fish carcasses floating on top of what we -- just days before -- believed to be a normal, healthy waterway.

I spend long hours behind closed doors with my colleagues and my Governor, helping to make the decisions that change the lives of all Marylanders. Everyday, I talk with watermen who are losing income; tourism representatives who are also suffering financially; members of the media looking for the answers we cannot yet provide; and citizens who are afraid to let their children swim in Chesapeake Bay tributaries.

And, with the hope of someday soon finding both the answers, and the solutions, I have members of my own staff working virtually 24-hours a day in a stressful and possibly dangerous environment. Today, seven of those staff members are part of the State's medical study with breathing problems and short term memory loss.

In Maryland, the health of our citizens, the quality of our lives and the strength of our economy depend on the Chesapeake Bay. Mr. Chairman, we need your help to ensure the health of this national asset, for today and for future generations.

Attachment to: Maryland Department of Natural Resources Secretary John R. Griffin
 Testimony before House Subcommittee on Fisheries Conservation
 Wildlife and Oceans Committee on Resources -- Thursday, Oct. 9, 1997 -- 10 AM

SUMMARY OF PFIESTERIA INVESTIGATIONS IN MARYLAND OCTOBER 6, 1997

BACKGROUND

THE POCOMOKE RIVER

- ▶ The Pocomoke River runs through Worcester and Somerset Counties. It is a scenic, tranquil Blackwater System, meaning that cypress swamps drain into the river. For decades, area watermen have made their living fishing and crabbing in the Pocomoke. The river also supports an abundance of other natural resources, including bald eagles.
- ▶ Other businesses along the Pocomoke include canoe rentals, charter fishing, and bed and breakfast inns. The predominant land use in the watershed is agriculture, primarily chicken production and associated farming (corn and soybeans for chicken feed).

THE ISSUE

- ▶ Fish with lesions, fish kills and concern over potential human health risks have generated considerable attention for the Pocomoke River this year.
- ▶ In October 1996, then again in April and May 1997, Pocomoke River watermen reported finding lesions on high percentages of their fish catches from the lower river.
- ▶ Lesions can result from many factors, such as injury and secondary infections, toxic chemical effects, viral infection, and potentially toxic dinoflagellates such as the recently discovered *Pfiesteria piscicida*.

ACTIONS

- ✓ Samples of lesioned fish, water, sediment and algae were collected by DNR scientists from the Pocomoke River and Sound in October 1996. Tests indicated water quality conditions were within healthy ranges, and tests for *Pfiesteria* were negative.
- ✓ When fish lesions were reported in April 1997, DNR assembled a state interagency team to investigate the problem under Governor Glendening's leadership. The team includes the Departments of Agriculture (MDA), Environment (MDE), and Health and Mental Hygiene (DHMH). The state team would work closely over the coming months with watermen and scientific experts to learn more about potential causes of the fish lesions. Interest groups, such as the Chesapeake Bay Foundation, were also asked to collaborate with the team.
- ✓ Representatives from the state team met with citizens from the Pocomoke River area in late May to discuss the state's investigation.
- ✓ Governor Glendening visited Pocomoke City on June 25. He toured the river, met with local watermen, officials and interested citizens, and emphasized his concern for the problem and commitment to finding solutions.
- ✓ DNR instituted an aggressive fish and water quality monitoring program. DHMH has issued health-related guidelines and is working with local health departments and experts from Johns Hopkins, University of Maryland, the Center for Disease Control and the National Institute of Health to investigate reports of illness from individuals who believe their symptoms are

associated with Pocomoke River water contact. MDE continues to evaluate point and non-point (runoff) sources of pollution, and MDA is reviewing farming practices in the watershed.

- ✓ Autumn 1996 and spring 1997 water samples illustrated some shifts in water chemistry (high acidity and low salinity) resulting from above average precipitation throughout 1996. It is possible these conditions may have stressed Pocomoke fish.
- ✓ Analyses of sediment chemistry found no evidence of significant contamination by heavy metals and pesticides.
- ✓ Algal samples were collected and forwarded to the laboratories of Dr. JoAnn Burkholder (North Carolina State University) and Dr. Karen Steidinger (Florida Department of Environmental Protection) to investigate the possible role of *Pfiesteria*. Both researchers are nationally-recognized experts in *Pfiesteria* research.
 - All DNR samples tested negative. However, in May 1997, a water sample collected from the Shelltown area by a Washington area television station tested positive for *Pfiesteria* in Dr. Burkholder's lab.
 - Under further examination by Drs. Steidinger and Burkholder, this species appears slightly different from that found in North Carolina and has thus far been labeled a "*Pfiesteria*-like" organism, pending further analysis.
- ✓ To help gather more accurate data, DNR began an aggressive monitoring program in July working together with watermen to quantify lesion rates and types of lesions observed. The program has concentrated on fishing efforts in the Shelltown and Pocomoke Sound areas where fish with unusual lesions have been found.
- ✓ At the direction of Governor Glendening, the state team convened a summit on Aug. 1-3, 1997 at Salisbury State University to seek input from other experts on the state's investigation. More than 60 experts from five states reviewed data and critiqued and fine-tuned the state's action plans for narrowing the scope of causes for the fish lesions, and helped to develop possible solutions. Pocomoke River watermen, local elected officials, area business owners and other interested citizens also participated.
- ✓ At the summit, the state's newly-formed Technical Advisory Committee of water quality, algal, and fish experts chaired by Dr. Donald Boesch, President of the University of Maryland Center for Environmental Science, reviewed action plans.

The committee concluded that many explanations are possible for the fish health problems on the Pocomoke, including physical irritation from microbial infections of stressed fish; harmful chemicals; secondary infections by bacteria, viruses, and fungi; *Pfiesteria piscicida*; and other microorganisms. The committee also surmised that it is unlikely that pollutants from regulated point source discharges are responsible for the lesions, but limited reviews are merited. Although there is no current data to provide a linkage, nonpoint source inputs were recommended by the committee as the primary focus of investigation. The state team will continue to work with the Technical Advisory Committee as new data and results are collected.

- ✓ DNR set up a toll-free hotline in late May to the DNR/NOAA Cooperative Oxford Laboratory for individuals to report fish with lesions on a Bay-wide basis.
 - More than 400 calls were made to the hotline through August, representing every geographic area around the Bay.

- ✓ DNR has had several regular meetings with commercial and charter boat fishermen throughout the spring and summer. Watermen were asked if they found unusual lesions on fish around the Bay. They reported seeing occasional signs of trauma like that seen in years past, as well as a bacteria common to stressed striped bass (rockfish) in the last few years. About 3 million recreational fishing trips are annually taken on the Bay, and tens of millions of fish are caught.
- As an additional effort to gain Bay-wide information, in July DNR provided 1,500 watermen with surveys and data sheets to record fish lesions observed while on fishing trips; 12 surveys have been received reporting fish abnormalities, geographically distributed around the Bay.
- DNR will continue to monitor information received from recreational and commercial fishermen to determine if any unusual patterns develop that require further investigation.

FISH KILLS

AUGUST 6

- Early in the morning on Wednesday, Aug. 6, hundreds of dead and dying fish were found by local watermen and on-board observers downstream of Shelldown at Williams Point, the lower Pocomoke River in Somerset County, Maryland.
- The kill continued for four days, with decreasing numbers of fish affected each day.
- Most of the fish were young menhaden; many had lesions. It was difficult to ascertain the total number of fish killed because of tides and gulls quickly eating the floating fish, but the estimate is 10,000 - 15,000.

ACTIONS

- ✓ The day of the fish kill, DNR was already in the process of establishing a field office in Shelldown. Scientists quickly responded on site with watermen to take the very important "fresh" fish, water and algal samples. Secretary Griffin was on-site within hours of the kill.

The short-lived nature of *Pfiesteria*-like organisms and the effects of tides and currents make it critically important to know the chemical and algal makeup of the water at the time that fish are dying or developing lesions.

- ✓ State and local health officials issued a public health advisory on Aug. 6. The public was notified to avoid all water contact in the area from Cedar Hall Wharf to the mouth of the river.
- ✓ When the fish kill continued for a second day, and because of reports from the area that the advisory was disregarded by some individuals, state and local health officials issued an indefinite public health closure order for the area at 4 p.m. Thursday, Aug. 7. The closed section of the river was patrolled by Natural Resources Police to help ensure compliance with the order.
- ✓ The closure remained in effect after the end of the fish kill on Aug. 9 until Wednesday, Aug. 13, when the river was reopened at 5 a.m.
- ✓ The state team held a public information meeting on Monday, Aug. 11 in Pocomoke City to brief citizens on investigation activities and enable them to ask questions of state officials.
- ✓ Some of the samples collected for *Pfiesteria* or "*Pfiesteria*-like" organisms in the area during the fish kill tested positive for the toxic dinoflagellate. It was immediate sampling that allowed for the identification of *Pfiesteria*-like organisms during the Aug. 6-9 kill. Dissolved oxygen concentrations measured at the same time were sufficiently high so as to rule out hypoxia or

anoxia as a primary factor in the kill. In addition to a *Pfiesteria*-like microorganism, DNR continues to investigate other possible agents at work in the fish kill.

AUGUST 26

- A fish kill began in Virginia waters of the Pocomoke Sound outside the mouth of the Pocomoke River on Tuesday, Aug. 26.

ACTIONS

- ✓ Maryland health officials issued an advisory that afternoon for the public to avoid water contact from the mouth of the river to Williams Point and a line straight across to the Maryland/Virginia state line Marker "M."
- ✓ Upon Maryland's investigation team findings of fish with lesions and low numbers of dead fish (menhaden) in Maryland waters from the Pocomoke Sound upriver to the Cedar Hall Wharf area on Aug. 27, health officials extended the public health advisory to Cedar Hall Wharf.
- ✓ On Aug. 28, after continued similar findings in the advisory area as well as further upriver, the public health advisory was extended to the Powell Wharf Road area.
- ✓ Following continued similar findings in the advisory area, in addition to preliminary health information released by the Department of Health and Mental Hygiene concerning its study of individuals being examined for possible health effects relating to river water contact, Governor Glendening closed the river on Aug. 29 from Powell Wharf Road to the mouth and into the Pocomoke Sound to a line from Williams Point to the Maryland/Virginia State Line Marker "M."
- ✓ Fish, water, sediment and *Pfiesteria* samples were taken. Toxic levels of a *Pfiesteria*-like organism have been confirmed.

SEPTEMBER 10

- ✓ Governor Glendening closed King's Creek off the Manokin River in Somerset County after a significant number of menhaden were found in distress with *Pfiesteria*-like lesions. Toxic levels of a *Pfiesteria*-like organism have been confirmed.

SEPTEMBER 14

- ✓ Governor Glendening closed a portion of the Chicamacomico River near Drawbridge Road in Dorchester County after a significant number of menhaden were found in distress and dying with *Pfiesteria*-like lesions. Preliminary test results of water samples from the area indicate the presence of toxic levels of *Pfiesteria*-like organisms.

NEXT STEPS

- ✓ Daily fish observations and periodic water quality testing, particularly after storm events to get a more accurate picture of runoff effects in the area, are being done through DNR's field station in Shelton.
- Water quality and *Pfiesteria* sampling is also being conducted related to any sudden increase in the incidence of fish with lesions or additional fish kills.
- ✓ U.S. Senators Sarbanes and Mikulski have worked with EPA and NOAA to provide \$500,000 in funding to support the state's investigation. Maryland's Congressional Delegation continues to assess the need for additional federal assistance. The state team is using the federal money for extensive laboratory tests and field work.
- ✓ U.S. Geological Survey has contributed lab testing for chemicals.

- ✓ NASA has donated a weather station to DNR's field office, which enables staff to study any possible connections of weather conditions to the situation in the lower Pocomoke.
- ✓ NOAA has loaned a vessel and personnel assigned to the Shelbtown command center.
- ✓ USF&WS will assist with fish sampling and analysis.
- ✓ Additional assistance with identification of *Pfiesteria*-like organisms is being coordinated through Drs. Burkholder and Steidinger.
- ✓ DNR Fisheries Service continues to study microbiology associated with fish with lesions and the disease process.
- ✓ In response to feedback from the Technical Advisory Committee, changes are underway to increase coordination and focus among the State's technical efforts to identify causes. The state's lead investigators met again with the committee and presented a hypothesis for review.
- ✓ On Sept. 9, DNR expanded its toll-free fish health hotline. The new hotline is manned 24 hours a day by trained personnel who can take complete reports, as well as refer callers requesting specific technical information to the proper resources within DNR or its sister agencies. The new system is an improved customer service and information gathering tool that will help DNR better identify any potential patterns of fish health issues.
- ✓ Governor Glendening recently broadened his action plan to help identify the causes of *Pfiesteria* toxicity and develop solutions to address it. The Governor has called on President Bill Clinton, Maryland's Congressional Delegation, Governors from nearby states, the U.S. Environmental Protection Agency, and other federal agencies to support Maryland's efforts to address this challenge. Additionally, the Governor has:
 - created a Blue Ribbon Citizens *Pfiesteria* Action Commission, chaired by former Governor Harry R. Hughes;
 - convened a Governor's Summit to discuss a regional approach to the *Pfiesteria* issue;
 - approved a \$2 million emergency appropriation to help Maryland farmers plant cover crops;
 - and committed \$500,000 for a comprehensive marketing campaign to better inform seafood wholesalers, retailers, and consumers about the quality and safety of Maryland seafood.
- ✓ Last week Maryland's scientific and medical experts, finalized a new protocol for the closing and reopening of rivers affected by *Pfiesteria* or *Pfiesteria*-like events. In accordance with that protocol, Governor Glendening announced the reopening of the Pocomoke River on Oct. 3.

WHAT WE KNOW THUS FAR ...

- 1996 was an unusual year for water quality. It was one of the wettest years on record. Rainfall in the watershed during June through October 1996 was well above the 81-year average. As a result, acidity of the river water at our long-term monitoring site near Pocomoke City was at 10-year record highs during July, September, and October.
 - In Pocomoke Sound, total nitrogen levels were also at 10-year highs and salinity was at 10-year lows during this period. These unusual water quality conditions may have stressed the fish's immune systems to the point that they were unable to fight off common infections.
- Nutrient (nitrogen and phosphorous) levels in the Pocomoke River and Sound are higher than average when compared to other Chesapeake Bay tributaries. Pocomoke Sound nitrogen levels have been increasing since 1986. There has been no trend in the phosphorous in the Sound or

in either nutrient in the River.

- ▶ The Pocomoke River does contain very high levels of dissolved organic carbon compared to other Chesapeake Bay tributaries.
 - Dissolved organic carbon comes from decaying plants and animals, and human and animal excrement. It is naturally higher in blackwater rivers such as the Pocomoke, but human activities may make it even higher. Although high levels of dissolved organic carbon are not usually associated with algae blooms, low dissolved oxygen, and other water quality problems, it is of interest in this case because some laboratory evidence suggests that high levels of dissolved organic matter may promote the growth of *Pfiesteria*-like organisms.
- ▶ Levels of chemical contaminants in Pocomoke Sound sediments are not high enough to cause fish health problems.
 - Chemical analysis of sediment at 5 sites in the lower Pocomoke River for 11 metals and 47 other pesticides, PCB's, and PAH's, revealed that none were at levels high enough to cause lesions or death in fish.
 - This does not eliminate the possibility that chemicals may be washing off the land after a storm event and briefly raising concentrations in the water sufficient to cause fish health problems. Hence, DNR's on-site responsiveness to test water quality following storms.
- ▶ In addition to a *Pfiesteria*-like microorganism, DNR continues to investigate other causes of fish lesions and the fish kill in the lower Pocomoke River. This is primarily because lesions were observed on fish prior to and during the kill that are not indicative of *Pfiesteria*.
- ▶ Since this organism can exist most often in a harmless state as part of the natural environment, we must consider that it appears likely that a host of environmental factors have come together on the Pocomoke River to allow such an organism to develop into toxic forms.
 - Fish lesions may be a function of sublethal concentrations of *Pfiesteria*-like organisms or a sign of yet other ecological stressors on this system. Identifying a toxic dinoflagellate as a contributor to the fish health problems on the Pocomoke River and the state's other two affected areas has certainly provided a major piece of the puzzle. However, other factors are almost certainly at work.
- ▶ Defining conditions that have generated fish kills, fish lesions and possible human health effects is a top priority for the interagency team working on the watershed.
 - Future water quality monitoring may then be able to assess on a regional basis the risk of fish kills and lesion incidence in a fishery.
 - Improved management of water quality and land use around the Bay may result from the knowledge gained during this work on the Pocomoke River.
 - Based on this analysis, the state team, Technical Advisory Committee, and tributary strategy teams will work together to identify additional measures and funding initiatives that may be used to further improve water quality Bay-wide.

**Testimony of Wayne McDevitt
Secretary of the North Carolina Department of
Environment and Natural Resources
Before the Subcommittee on Fisheries Conservation, Wildlife and Oceans
October 9, 1997**

Introduction

Thank you, Mr. Chairman, my good friend Representative Walter Jones, and members of the Subcommittee on Fisheries Conservation, Wildlife and Oceans. I am Wayne McDevitt, Secretary of the N.C. Department of Environment and Natural Resources.

On behalf of Governor Hunt, I want to thank you for giving us this opportunity to testify before your subcommittee on the health of our fisheries stocks and habitats, and our efforts to address water quality problems that impact them. Additionally, I want to thank our federal partners from the National Oceanic and Atmospheric Administration, EPA, the Centers for Disease Control and Prevention, the National Institute for Environmental Health Sciences, the Fish and Wildlife Service, and other agencies for their assistance and willingness to work with us and other states on this important and shared environmental challenge. There are several FY98 appropriations initiatives supported by members of this subcommittee and others that will fund the research and response that is needed in addressing this challenge. We urge you to continue pushing for these new funds to target pfiesteria.

We in North Carolina have been working on pfiesteria for a long time. It was through a cooperative federal/state partnership that much of the early work on pfiesteria was done. Several of Dr. JoAnn Burkholder's early publications were funded by the Albemarle-Pamlico Estuarine Study -- or APES. APES was a joint project of the U.S. Environmental Protection Agency and the N.C. Department of Environment, Health and Natural Resources. That far-reaching and progressive study, initiated in 1987, looked at water quality issues in an entire estuary system.

We recognize that nutrient loading is a regional issue and could be a global problem. We must work cooperatively (both state and federal) to address nutrient loading in order to clean up our waters.

We welcome the chance to discuss the protection of our oceans and coastal waters with you. We appreciate this panel's role in fisheries management and research and the protection of coastal and marine environments, and we value your concern about the vitality of our estuarine systems.

Importance of North Carolina's Coastal Fisheries

Before I go through the actions we are taking in North Carolina to address water quality problems and to protect our fisheries, I want to take a moment to tell you about North Carolina and the importance of the state's role in protecting marine fisheries up and down the entire Atlantic Coast. North Carolina has the largest estuarine system of any single state on the Atlantic coast--*2.3 million acres*. Our coastal fisheries are overwhelmingly estuarine-dependent. Species must utilize estuaries to complete their life-cycle: spawning, nursery areas, feeding areas,

and migration routes. This is why water quality protection and restoration efforts are so critically important.

About 90 percent of commercial landings are of estuarine-dependent species. They include striped bass, blue crab, shrimp, summer flounder, hard clam, and weakfish. Meanwhile, about two-thirds of recreational landings are of estuarine-dependent species, including spotted seatrout, red drum, southern flounder, Atlantic croaker and spot. In North Carolina, almost 150,000 acres of estuarine waters designated as nursery areas and about 200,000 acres of seagrass habitat support many important species. Coastal rivers provide spawning and nursery areas for American shad, river herring, striped bass, and sturgeon (an endangered species).

Fish from North Carolina estuaries and coastal rivers migrate throughout the Atlantic coast and support significant commercial fisheries along the Atlantic seaboard. River herring tagged in the Albemarle Sound have been caught off of Cape Cod. Southern flounder tagged in the Pamlico Sound area are caught in South Carolina and Georgia. Striped bass tagged off the Outer banks have been recaptured from the Chesapeake Bay to Maine.

Cape Hatteras represents the major dividing point between northern and southern habitats, fish and fisheries. Southern shrimp and subtropical reef fish are taken in abundance in North Carolina, northern lobster and Florida spiny lobster are taken off our coast and cod, pollock, Atlantic mackerel are often found off our Outer Banks in the winter. It becomes clear that all of us here today have a common and shared interest in protecting these important natural and economic assets.

North Carolina annually ranks among the top 10 states in the nation in both commercial and recreational landings, and North Carolina leads the Atlantic coast states in landings of croaker, spot, bluefish, blue crabs, summer flounder, southern flounder and sharks. Our coastal fishing industry (commercial and recreational) contributes more than \$1 billion annually to the state's economy. We have about 8,000 licensed commercial fishermen in North Carolina, and about 1.2 million persons fish recreationally with rod and reel annually in our coastal waters.

Because of the importance we place on our fisheries resources, habitat and industries, North Carolina has made a substantial investment in fisheries and marine sciences research. Our Morehead City-Beaufort marine science complex, which includes scientists from Duke University, the University of North Carolina at Chapel Hill, the North Carolina State University Seafood Lab, the National Marine Fisheries Service, and the N.C. Division of Marine Fisheries, is among the largest and best in the world. This research center is vital to our collective understanding of how to restore, protect and sustain our valuable coastal fisheries for the long term.

Seafood and Public Health Issues

As with all issues related to environmental conditions, we have a responsibility to provide the best information to our citizens. We must educate people about possible risks associated with our findings, but we also must address misinformation. People in our respective states are avoiding seafood consumption unnecessarily. There are reports on reduced sales of fish in Maryland, North Carolina and surrounding areas. In North Carolina, crab sales are down about

40 percent in recent weeks, due in large part to consumer concerns. In addition, we have read reports where consumers are also avoiding *ocean* fish, such as tuna.

We must continue to do everything we can to learn more about pfiesteria and its effects on human health, fish and water quality. But at the same time, it is also important to remind people that the primary fish we've seen affected by toxic pfiesteria is menhaden, which is not used for human consumption, but is used for fertilizer, leather tanning and to make paint.

While we are aggressively trying to learn more about the pfiesteria organism and its potential health effects on humans, we have had no confirmed cases of people who have experienced pfiesteria-related problems from fish consumption, nor do we have reason to believe that eating marine fish caught in our state poses a risk to human health. However, as a measure of caution, for several years we have been warning our people not to eat fish with sores, or those caught in the vicinity of a fish kill.

Dr. JoAnn Burkholder, the researcher from North Carolina State University who spoke to you earlier, has said on a number of occasions that pfiesteria is a cause for concern not alarm. We need to work together to inform and educate the people in our respective states about the precautions they need to take to protect their health while making sure our fishing and crabbing industries are not unnecessarily affected.

I want to highlight two of our programs that are dedicated to making sure our coastal waters fisheries are safe. First, our *Division of Environmental Health's Shellfish Sanitation Program* monitors, evaluates and classifies more than 2.1 million acres of coastal waters to determine their safety for shellfish harvesting and consumption. As a result of this monitoring, the Division has recommended to our Division of Marine Fisheries that 363,000 acres be permanently closed to shellfish harvesting because of water quality problems, primarily fecal coliform (not Pfiesteria). To date, there have been *no documented cases of illness associated with shellfish harvested in North Carolina waters.*

The second major program is our *Recreational Water Quality Monitoring Program*, initiated by Governor Hunt because of mounting concerns about the safety of North Carolina waters for fishing, swimming, boating and other water-based activities. Through a network of more than 1,300 sampling sites throughout coastal North Carolina, program staff have collected and analyzed water samples for fecal coliform and other bacteria (*escherichia coli* and enterococcus). If testing reveals that bacteria levels are too high, staff post signs advising the public against swimming in that area.

Next Steps

As I said, we must learn more about this organism. Pfiesteria is a symptom of the greater problem. We do know that the health of humans, the health of our waters and the health of our fish are interwoven. We also know that the root cause of our problem is that too many nutrients - (nitrogen and phosphorus) -- are getting into our waters. Dr. JoAnn Burkholder and others have told us that significant nutrient reduction is critical if we are going to restore our rivers, and they are right.

The Atlantic Coast states represented on the panels today--North Carolina, Delaware, Virginia and Maryland--share a common problem. We also share a sense of urgency in addressing water quality problems. Most of us have large estuaries with slow-moving water, strong agricultural economies, and growth in both population and land use. The potential impacts of that growth are obvious, and the need to address them is just as obvious. We greatly support a holistic approach to addressing this problem.

Pfiesteria was first identified in North Carolina and North Carolina intends to be a major player in solving this problem. We will work with our federal and regional partners as we move forward.

Governor Hunt's charge to me has been quite clear. Clean up and restore our waters and do whatever is necessary to make it happen. We're committed to doing that in North Carolina. I have included background materials, including a chronology of events, on North Carolina's water quality initiatives for your information. We all must work together to find the answers. To find the solution we must involve the federal government, scientists such as Dr. Burkholder, municipalities, industries, farmers, foresters and others. Additional research is also needed and needs our support. If we are to make good decisions, they must be based on good science.

In North Carolina, we have witnessed fish kills, algal blooms and degradation of some of our waterways and estuaries due to excess nutrients. We have acted to combat our nutrient problems and have made some meaningful progress. We need to follow-through on the programs we have initiated and build upon the progress we have made so far. It is clear we need to do more to restore our coastal waters.

As I said we have taken a number of steps to address our nutrient problems and I want to highlight some of the more significant steps we've taken:

- The Governor and our state lawmakers just concluded what has been referred to as the most important legislative session for the environment in our history. Perhaps most importantly, Governor Hunt signed the Clean Water Responsibility Act, a far-reaching, progressive and aggressive environmental law, which puts a two-year moratorium on hog farms in the state, reduces nutrient limits for wastewater dischargers and non-point sources and includes provisions for improved land-use management;
- Governor Hunt led the charge for fisheries reform legislation enacted this year to protect stocks and habitats. Among other things, this landmark act requires the preparation of fishery management plans for all important fisheries, the preparation of coastal habitat protection plans and increased penalties for violations;
- We have created a scientific advisory council on water resources and coastal fisheries management;
- We have developed a strategy to reduce nutrients in our troubled Neuse River and will continue our basinwide planning efforts to address water quality concerns;
- We have established a clean water management trust fund, which provides more than 50 million each year to water quality protection initiatives;
- We have established a wetlands restoration program;
- We have toughened our enforcement policies;
- We are strengthening our sedimentation and erosion control programs;

- We established a rapid response team to investigate fish kills and expanded our coastal recreational water quality testing program to protect public health;
- We have toughened siting, permitting and operating requirements for intensive livestock operations;
- We have strengthened our Agricultural Cost Share Program that assists farmers in controlling run-off from crops, fields and feedlots;
- ***We have also established a medical team to examine the health effects of pfiesteria and a hotline for citizens to call for assistance;***
- We have significantly stepped up our environmental education efforts to educate our citizens as to how their activities affect their river basins. I have attached a brief summary of North Carolina's initiatives, a chronology of events and actions, background information on the major legislation and descriptions of the projects funded through the Clean Water Management Trust Fund; and
- Finally, North Carolina has made a major financial investment in the waters of our state over the last two years. In that time alone, the Governor has approved over \$147 million to fund important research, programs and initiatives.

We have taken some very important steps, but we've got more to do. In September, Dr. David Bruton, our Secretary of Health and Human Services, and I met with our North Carolina congressional delegation and with governors from five states. We all stand ready to join as full partners on this issue. We talked with them about our needs. In particular, we re-emphasized Governor Hunt's commitment to establishing a Center for Applied Aquatic Ecology at North Carolina State University, where Dr. Burkholder does her research. Congressman Jones has introduced legislation to authorize funds to support this Center, which I want to note the subcommittee has the unanimous support of the North Carolina Congressional delegation. On behalf of Governor Hunt, I want to thank the delegation for their support on this and to urge favorable action as quickly as possible.

In North Carolina, we are also working hard to:

- Follow through on our basinwide planning efforts designed to reduce nutrients from run-off and point sources;
- Provide additional funds for vital research; I am particularly interested in research on ways to improve waste management at animal livestock facilities;
- Address pollution from atmospheric deposition into our waterways;
- Foster the commitment among stakeholders to do what needs to be done;
- Maintain tough enforcement;
- Work very closely with Dr. Burkholder and environmental groups, such as the Neuse River Foundation, represented here today by Rick Dove;
- Identify additional ways to fund the more than \$12 billion in wastewater treatment needs in North Carolina; and
- We also will be working diligently in our Marine Fisheries Division to collect data and conduct the research needed to learn more about the relationships between fisheries productivity, habitat conditions and water quality.

In order to do all of these things, we have to have strong, clear regulations, strong legislation, strong enforcement, good information, support for research, and public support.

All of the Atlantic states could benefit from assistance from Congress in the following areas:

- 1) Increased funding to support pfiesteria research. We urge your support for the appropriations items addressing this issue which can significantly help in this area.
- 2) Funding for improving wastewater treatment plants;
- 3) Support for improved technology for point dischargers;
- 4) Support for innovative technology for wastewater treatment plants;
- 5) Support for improved and innovative technology for the management of animal waste; and
- 6) Stronger tools for addressing nonpoint source pollution in the reauthorization of the Clean Water Act.

We welcome the assistance of this subcommittee, the National Oceanic and Atmospheric Administration, EPA, the Centers for Disease Control and Prevention, the National Institute for Environmental Health Sciences, U.S. Fish and Wildlife, other federal partners, and other states. We strongly support the FY98 appropriations provisions that are currently being considered by Congress to support and expand research into the characteristics of and proper response to pfiesteria.

To maximize the efficiency and effectiveness of that assistance, we need to further define the appropriate state and federal roles in dealing with issues such as this one. In North Carolina last year, I worked on the coordinated response to Hurricane Fran. The ability to work closely with FEMA (Federal Emergency Management Agency) and other federal agencies greatly enhanced our service to the public during an extremely difficult time. A similar, ongoing mechanism for coordinating the state and federal response to pfiesteria would benefit us all.

Conclusion

As you can tell, there is a sense of urgency here. We must move forward with a strong results-oriented resolve, with prime attention on accountability and good information.

Once again, we're here to say and show we are committed. We're pleased to join in this regional approach to a common problem. We are poised to join whatever efforts are necessary to improve coordination, communication, understanding, the condition of our waters, the long-term protection of our fisheries and their habitats, and, most importantly, the health and safety of our people.

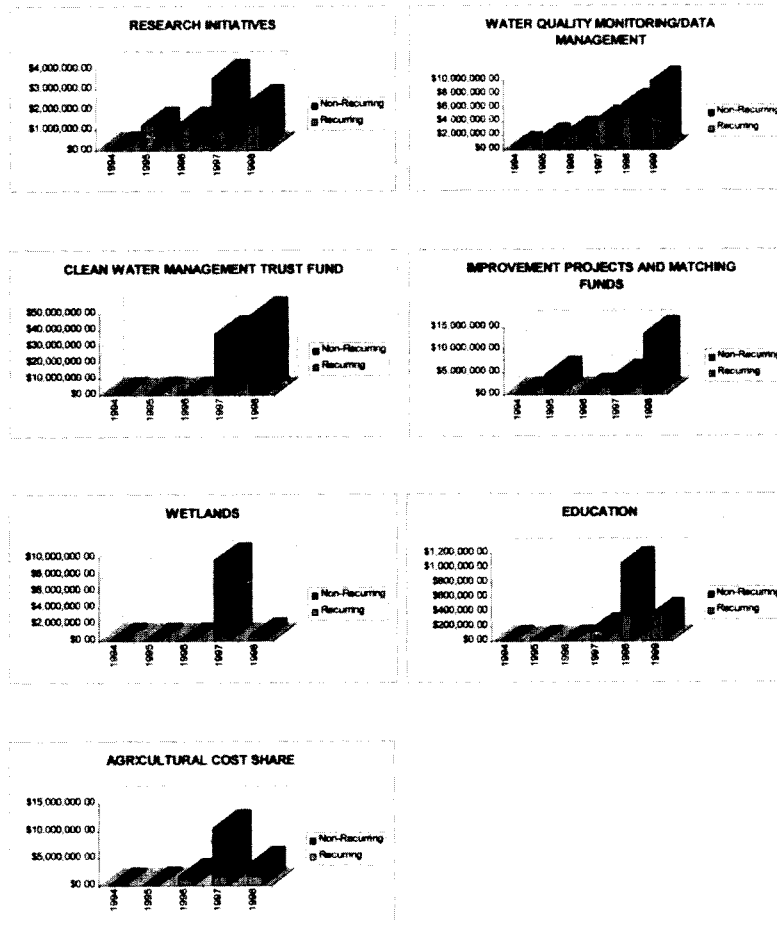
Thanks again to you Mr. Chairman, Mr. Jones, and members of the subcommittee. I will be pleased to address any questions you may have.

Table 24.1. Intoxication Syndromes Caused by Phycotoxins Consumed in Seafood.

Disease	PSP	NSP	ASP	DSP	Ciguatera	Puffer Fish
Causative Organism	Pelagic ¹ Dinoflagellate	Pelagic Dinoflagellate	Pelagic Diatom	Pelagic or Benthic Dinoflagellate	Epibenthic ² Dinoflagellate	Bacteria?
Major Transvector	Shellfish	Shellfish	Shellfish	Shellfish	Fish	Fish
Geographic Distribution	Temperate to Tropical World-wide	Gulf of Mexico Japan, New Zealand	Canada, NW U.S.A.	Temperate World-wide	Sub-Tropical to Tropical World-wide	Japan, World-wide
Major Toxin (Number)	Saxitoxin (18+)	Brevetoxin (10+)	Domoic Acid (3)	Okadaic Acid (4)	Ciguatera (8+) Saxitoxin, Maitotoxin	Tetrodotoxin (3+)
Neuro-Mechanism	Na ⁺ Channel Blocker	Na ⁺ Channel Activator	Glutamate Receptor Agonist	Phosphorylase Phosphatase Inhibitor	Na ⁺ , Ca ²⁺ , Channel Activators	Na ⁺ Channel Blocker
Incubation Time	5-30 min	30 min to 3 hr	hours	hours	hours	5-30 min
Duration	days	2 days	years	days	years	days
Acute Symptoms	n.v.d	n.v.d, b, t, p	n.v.d.a, pr	d, n.v	n.v.d, t, p	n.v.d.p,r,bbp
Chronic Symptoms	none	none	amnesia	none	paraesthesias	none
Fatality Rate	1-14%	0%	3%	0%	<1% (0.1-12%)	60%
Diagnosis	clinical, mouse bioassay of food, HPLC	clinical, mouse bioassay of food, ELISA	clinical, mouse bioassay of food, HPLC	clinical, mouse bioassay, HPLC, ELISA	clinical, mouse bioassay, immunosassay	clinical, mouse bioassay, Fluorescence
Therapy	Supportive (respiratory)	Supportive	Supportive (respiratory)	Supportive	mannitol? TCA?	Supportive (respiratory)
Prevention	red tide and seafood surveillance, report cases	red tide, then seafood surveillance, report cases	seafood surveillance, report cases	seafood surveillance, some red tide, report cases	seafood surveillance, report cases (clusters)	regulated food preparation, report cases

¹pelagic water column blooms of motile single celled microalgae. ²epibenthic forms live on solid surfaces or macroalgae and are inadvertently consumed during fish grazing activities. Taken together, it is readily evident that the toxins of bloom organisms accumulate in filter-feeders, while toxins of epibenthic forms accumulate in fish. n=nausea, v=vomiting, d=diarrhea, p= paraesthesias, r= respiratory depression, b= bronchoconstriction, t= reversal of temperature sensation, a= amnesia, bbp= decreased blood pressure. Letters in bold indicate pathogenomic symptoms (adapted from Sakamoto, 1987; Sims, 1987; and Baden *et al.*, 1994).

North Carolina Funding for Water Issues



Summary of North Carolina Initiatives to Improve Water Quality

Clean Water Responsibility and Environmentally Sound Policy Act - The bill, signed by Governor Hunt on August 26, 1997, has been hailed by environmentalists as the most significant piece of environmental legislation in North Carolina history. It puts a moratorium on hog farms, requires comprehensive planning across the state to ensure clean water and gives counties the right to zone large hog farms and restricts where hog farms can be built. The new law also tightens limits on the amount of nitrogen cities and industries can discharge into nutrient sensitive waters, requires additional stormwater controls and authorizes studies of water pollution.

Marine Fisheries Reform Legislation - The legislation, passed by the General Assembly during the 1997 session, is designed to improve fisheries management in North Carolina. It requires that detailed plans be developed for improving fish habitats and managing fish stocks. It also calls for stricter enforcement of fisheries laws, including increased penalties for illegal fishing, higher fees for commercial licenses and a cap on the number of licenses issued. The reform legislation addresses four key areas: resource planning and management, organization, licensing, and law enforcement and public education.

Sedimentation & Erosion Control Plan of Action - In response to Gov. Jim Hunt's call to crackdown on sediment in North Carolina's waterways, the State Sedimentation Control Commission has adopted a plan to reduce amounts of the pollutant reaching the state's rivers and streams. The plan, which addresses erosion from construction projects, calls for expanding and enhancing erosion control requirements, toughening enforcement practices available to the state and locally delegated programs, and increasing technical training and education.

Enhanced Enforcement Program - On August 7, 1997, N.C. Department of Environment and Natural Resources Secretary Wayne McDevitt directed the state's water quality programs to take stronger enforcement actions against polluters of North Carolina's waterways. McDevitt has called for 1) increased penalties for water quality violations; 2) a plan for improved "bad actor" enforcement, including consideration of Department-level environmental crimes investigation capability, streamlined permit revocation processes, increases in the statutory caps on penalties, and any other changes, that are crucial to having top-notch "bad actor" enforcement capability in water quality protection programs; and 3) a review of how divisions now do water quality enforcement and otherwise encourage compliance and recommendations on steps that should be taken to strengthen compliance and enforcement policy for water quality. Time frame for initial report: by September 2, 1997.

Governor's Water Quality Initiative - On May 1, 1997, Governor Jim Hunt announced a plan to make sure the state's waterways are cleaner and safer through stepped up monitoring of coastal waters, additional resources for pfiesteria research and a new Neuse River Rapid Response Team. Coastal recreational water monitoring efforts were expanded to include more than 1,300 sites. The Rapid Response Team is equipped to respond to fish kills quickly in order to better determine causes and conditions.

Neuse River Nutrient Sensitive Waters Strategy - The N.C. Environmental Management Commission has developed a plan for managing the Neuse River's nutrient pollution problems. The strategy's goal is to reduce by 30 percent the loading of nitrogen into the Neuse River by municipalities, factories, developments and farmers. The plan includes provisions involving protection of both sides of streams from nutrient run-off, wastewater discharges, stormwater management, agricultural best management practices (BMPs), and application of nutrients to golf courses, recreational lands, residential, commercial, industrial, right-of-way or other turfgrass areas.

Clean Water Management Trust Fund - The fund, created by the 1996 General Assembly, is established to help finance projects that specifically address water pollution problems and focus on upgrading surface waters, eliminating pollution, and protecting and conserving unpolluted surface waters, including urban drinking water supplies. This fund is also intended to be used to build a network of riparian buffers and greenways for environmental, educational and recreational benefits. It is also expected to enhance wildlife and marine fisheries habitats in the state. The trust fund generates approximately \$50 million annually.

Wetlands Restoration Program - The restoration program, passed by the 1996 General Assembly, established in the Department of Environment and Natural Resources a non-regulatory statewide wetlands restoration effort for the acquisition, maintenance, restoration, enhancement and creation of wetland and riparian resources that contribute to the protection and improvement of water quality, flood prevention, fisheries, wildlife habitat and recreational opportunities. Its purpose is to restore wetlands functions and values throughout North Carolina which will result in a net increase in wetlands acres, functions and values in each of the state's 17 river basins.

Senate Bill 1217 - This legislation includes the recommendations of a Blue Ribbon Commission on Animal Waste which was convened to address issues related to the management of waste generated by intensive livestock operations in North Carolina. It requires the permitting of all animal waste management facilities and requires inspection of those permitted facilities. It also requires the certification of animal waste management system operators.

Nitrogen Reduction - An act approved during the 1996 General Assembly will improve water quality by establishing a goal to reduce the average load of nitrogen delivered to the Neuse River estuary from point and nonpoint sources by a minimum of 30 percent of the average annual load for the period 1991 through 1995 by the year 2001 and requires the State Environmental Management Commission to develop a plan to achieve this goal.

Strengthened Agricultural Cost Share Program - The N.C. Division of Soil and Water Conservation has been working diligently to increase statewide compliance by animal operations and to improve processes for the distribution of cost share funds with a focus on water quality protection. The division is conducting performance reviews of county programs which have improved the targeting and tracking of the funds.

Environmental Education - North Carolina has initiated a series of environmental education efforts to support the river basin strategy. They include:

- 1) Executives of 10 major home lawn fertilizer manufacturers and lawn care services from North Carolina, Florida, Georgia, Alabama, Virginia and Ohio are collaborating to use their corporate policies, resources, networks and employees to raise public awareness of natural river basin systems and human impacts on these systems. The program will go be made public in spring of 1998.
- 2) Carolina Power & Light, Duke Power and North Carolina Power companies are collaborating to implement an adult environmental education initiative using billings to raise public awareness of river basins in North Carolina. The inserts will reach over 2 million households four times in two years.
- 3) The North Carolina river basin environmental data is being integrated into classrooms as a result of teacher training workshops using geographic information systems (GIS) to develop classroom activities.
- 4) The Department of Transportation has erected "Neuse River Basin" signs at 38 locations along major highways in 12 counties in the Neuse River Basin to make the traveling public aware that they live and work within the basin.

NORTH CAROLINA CHRONOLOGY

December 1997	N.C. Environmental Management Commission is expected to vote on the final Neuse plan.
October 7, 1997	Public hearing scheduled for Neuse River Nutrient Sensitive Waters Strategy, which is designed to reduce nitrogen loading to the Neuse by 30 percent.
September 9, 1997	Toll-free hotline up and running.
September 4, 1997	N.C. public health officials request immediate scientific assistance from CDC.
September 2, 1997	N.C. announces that it will establish toll-free hotline to seek folks who may have been exposed and sickened by <i>Pfiesteria</i> . It also announces the appointment of a small group of medical researchers to assess existing data---recommend additional data needs and interim public health policy.
August 29, 1997	N.C. public health officials notified that Maryland researchers have identified a distinct pattern of illness in persons exposed to waters of the Pocomoke river where an ongoing fish kill was in progress. <i>Pfiesteria</i> and similar other <i>Pfiesteria</i> -like organisms were identified in the area.
August 26, 1997	The N.C. General Assembly enacts and Governor Jim Hunt signs the Clean Water Responsibility Act, which puts a two-year moratorium on hog farms in the state, reduces nutrient limits for wastewater discharges and non-point sources, and includes provisions for improved land use management.
August 19, 1997	The State Sedimentation Commission adopts a plan of action to reduce amounts of erosion and sediments to N.C.'s waters.
August 6, 1997	DENR Secretary Wayne McDevitt calls for stronger enforcement program for water quality regulations, including increased penalties for violations and an improved bad actor enforcement.
Summer 1997	State public health staff begin preliminary discussions with Centers for Disease Control and Prevention (CDC) staff regarding a long-term investigation of <i>Pfiesteria</i> associated illness.

May 1997	Governor Hunt announces a water quality initiative, which includes the establishment of a Rapid Response Team in New Bern to report quickly to fish kills, expanded water quality monitoring for coastal waters and additional funding for <i>Pfiesteria</i> research.
Spring 1997	Fish kill precautions published and local health departments throughout the coastal region were encouraged to distribute these guidelines.
1996-1997	Public health staff continued to solicit case reports of illness possibly associated with <i>Pfiesteria</i> . Several meetings with physicians practicing in the coastal areas of N.C. were organized--at each meeting state public health staff requested reports of any illness that might be related to <i>Pfiesteria</i> . Every report has been followed up with the attending physician. To this date, no case of illness has been clearly linked to an environmental exposure to a fish kill or <i>Pfiesteria</i> .
Summer 1996	N.C. General Assembly passes legislation requiring a 30 percent reduction in nitrogen load to the Neuse River. Wetland restoration program established in DENR. Clean Water Management Trust Fund established by the N.C. General Assembly to help finance clean water projects.
June 26, 1996	N.C. General Assembly passes Senate Bill 1217, which provides staff for annual animal waste operation inspections and requires those facilities to apply for permits from the state Division of Water Quality.
Spring 1996	Fish kill precautions published and local health departments throughout the coastal region were encouraged to distribute these guidelines.
Winter/Spring 1996	State public health staff expand contacts with researchers working in the <i>Pfiesteria</i> -related studies and with experts in marine biology and neuroepidemiology.
December 1995	SeaGrant selects four areas for funding: 1) health survey of N.C. crabbers; 2) affect on seafood quality and safety; 3) small mammal studies to test for neurotoxic effects; and 4) studies to characterize activation, life cycle and population dynamics of the organism.

November 1995	Last of the lab workers medical records secured by state public health workers.
Fall 1995	State public health physicians review all reports that come to state public health attention (including follow-up on media reports) of skin rash, ulcers or other skin conditions associated with water contact suggesting a causal link. This review involved consultation with attending physicians and consultant dermatologists, with medical records review when appropriate. The review found that most cases were consistent with well-established causes of skin disease other than <i>Pfiesteria</i> , with no distinct pattern to the cases without a clear etiology. A parallel investigation with veterinarians and wildlife rehabilitators uncovered no evidence of animal disease linked to fish kill exposures.
October 25, 1995	The warning and closure are lifted, but the recommendations for precautions in the vicinity of a fish kill are republished.
October 9, 1995	A ten-mile stretch of the lower Neuse is closed to fishing. State marine fisheries move to physically stop fishermen from entering the area.
October 6, 1995	State Health Director issues a public health warning, cautioning citizens and area visitors to avoid contact with waters associated with the fish kill. A detailed list of precautions developed by public health staff accompanied the warning. Any person experiencing illness that might be related to a fish kill exposure was urged to seek medical attention. The county health department, in conjunction with the state, initiated surveillance for water associated illness and surveyed local primary care physicians, dermatologists, emergency rooms, vets and wildlife rehabilitators.
September/October 1995	A prolonged fish kill associated with <i>Pfiesteria</i> occurred on the Neuse River.
August 1995	N.C. Sea Grant issues Formal Request for Proposals. Proposals were sought to address: 1) characterization of <i>Pfiesteria</i> toxin and quantification of consequences of toxin exposure on fish and humans; 2) assess the potential of <i>Pfiesteria</i> to have human health impacts on fishermen and other users of coastal waters; 3) determine the ecological triggers for toxin production; 4) determine how <i>Pfiesteria</i> is

activated and stimulated, and how it changes forms and exerts its impacts.

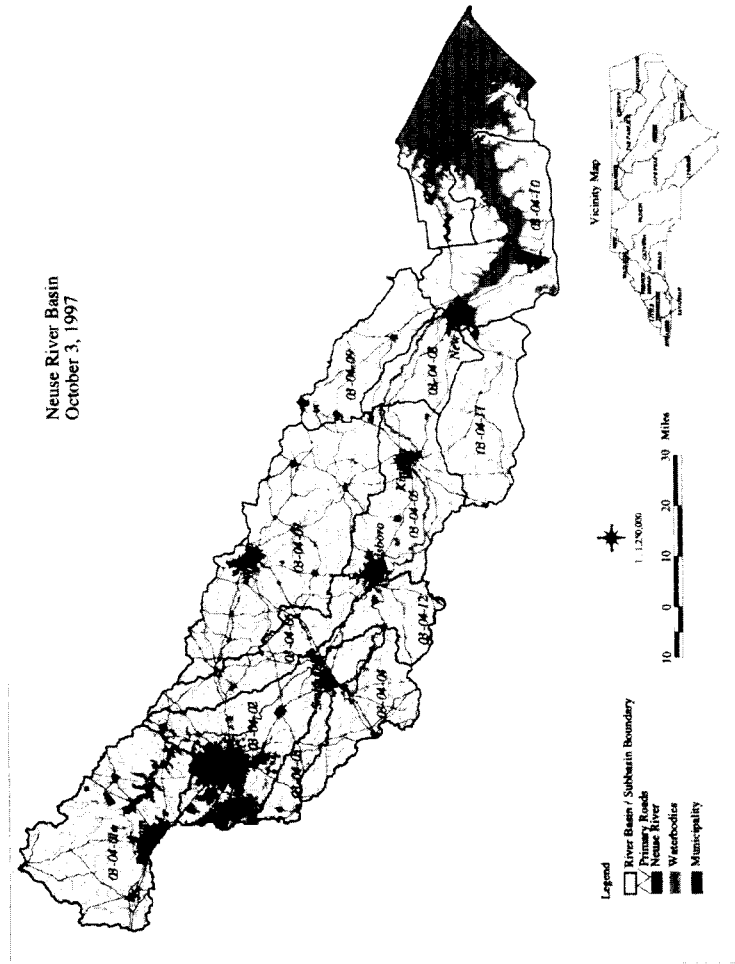
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| Summer 1995 | Animal waste legislation passes, requiring certification/training of operators and enacting siting restrictions to prevent water pollution. |
| Summer 1995 | Three <i>Pfiesteria</i> fish kills investigated by public health staff. Interviews conducted by experienced state public health staff. 89 people (fishermen, state workers, and members of the media) were reported to have been exposed. 69 were contacted and initially interviewed. Of this group, 32 met the protocol definition of exposure and completed a full questionnaire. Further medical evaluations were recommended for five persons with persistent cognitive complaints and three of them completed a battery of neurologic and neuropsychological tests. Marked inconsistency in symptom patterns was noted among persons exposed to the three <i>Pfiesteria</i> -associated fish kills that were studied. Neuropsychologic tests results were equivocal. Because exposures could not be objectively quantified or verified, dose-response analysis was not possible and conclusions about a causal association between exposure and symptoms were not deemed appropriate. |
| June 1995 | Attending physician grants access of some lab workers medical records. |
| Fall 1994 | <p>\$575,000 in state funds identified and transferred for use in <i>Pfiesteria</i> research to SeaGrant.</p> <p>State public health officials seek interviews with persons who had been reported to have symptoms after lab exposure. Information from the completed interviews was used during late 1994 to develop plans for a retrospective health study among fishermen and a rapid health survey of persons exposed to fish kills associated with <i>Pfiesteria</i>. As a result of reservations raised about a study of fishermen conducted by state public health staff, a decision is made to defer to SeaGrant researchers on this retrospective health study.</p> <p>State public health staff developed a protocol for investigating potential adverse health effects in individuals exposed to <i>Pfiesteria</i> fish kills. This protocol laid out responsibilities among state agencies for notification of public health staff when a <i>Pfiesteria</i> fish kill is suspected.</p> |

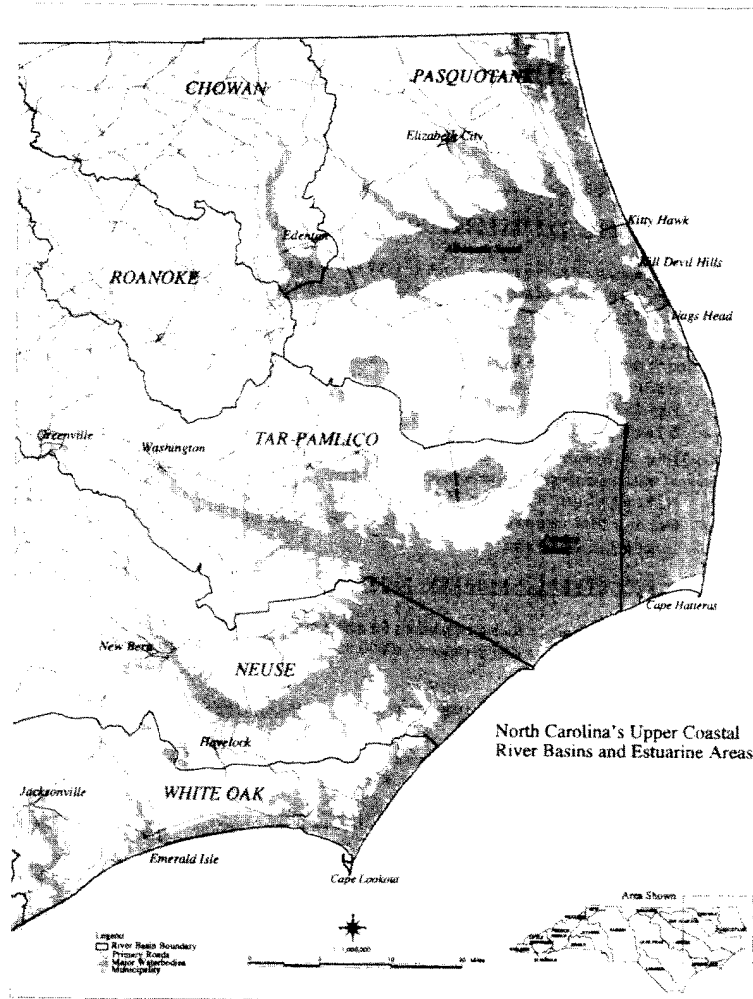
July-August 1994	A panel of scientists from federal, state and the university system is convened to review data and comment on needed research. Principal recommendations of this group for future studies were a retrospective health study among fishermen working waters where <i>Pfiesteria</i> exposure was likely, a rapid response evaluation for health effects among persons exposed to fish kills associated with <i>Pfiesteria</i> , animal bio-assay studies to better define health effects that might be associated with <i>Pfiesteria</i> , a retrospective survey of persons with lab exposure and a symptom survey of state water quality employees.
June 1994	Medical Records of lab workers with suspect illness are requested from attending physician, but access is denied. Transfer of \$575,000 in funds that would have reverted at the end of the fiscal year (they were originally designated as crippled children funds) to <i>Pfiesteria</i> research.
May 1994	Phone interviews conducted with four persons reporting symptoms.
April/May 1994	State public health staff engage in discussions with Dr. Burkholder and others.
April 1994	N.C. State Health Director Dr. Ron Levine and other staff meet for the first time with Dr. Burkholder. She presents her findings and suspicions about the potential human health problems. A medical epidemiologist with prior experience in investigation of dinoflagellate-associated illness and two peer reviewed publications concerning dinoflagellates/public health is assigned to follow up.
August 1993	Burkholder, Noga and others publish a paper, "The Role of a Newly Discovered Toxic Dinoflagellate in Finfish and Shellfish Kills in the Neuse and Pamlico River estuaries (Also funded by APES). The report shows: <i>Pfiesteria</i> has a complex life cycle with transformations into varying phases from flagellated cells to star shaped filipod amoebae, toxic vegetative cells emerge from benthic cysts in associated finfish excreta and the dinoflagellate appears in the presence of live finfish and encysts after the fish die.

March 1993	Noga, Burkholder and others publish a study (funded by APES) to determine the relationship between water quality and ulcerative mycosis in Atlantic Menhaden. The study finds: low salinity is favorable to disease development, decreasing fall temperatures appear to increase the disease, no correlation between the disease and inorganic nitrogen and chlorophyll a, the relationship of the disease and the dinoflagellate density is uncertain but there is no strong evidence for correlation between the two.
February 1993	North Carolina's water quality nondischarge rules for livestock farms go into effect----setting standards and management requirements to reduce run-off and spills from animal operations.
July 1992	First publication about the yet to be named dinoflagellate appears in <i>Nature</i> , entitled "New phantom dinoflagellate is the causative agent of major estuarine fish kills."
September 1991	Dr. Burkholder presented DEM with results of her tests on the then unnamed organism, which is killing fish at North Carolina State University's vet school lab. It is described as having unusual qualities---including a flagellated form, preference for salinity of 15 ppt and use of a peduncle for feeding. It is also noted that the fish behave erratically before dying, with multiple tests in aquariums.
May-Aug. 1991	Dr. Burkholder reports that she has found the dinoflagellate in conjunction with a fish kill in an aquaculture pond in Beaufort County and fish kills in the Pamlico and Neuse Rivers. She also reports that she has found the dinoflagellate in samples from Delaware's Indian River.
Summer 1991	DEM biologists look at samples of the dinoflagellate with Dr. JoAnn Burkholder. It appears that the dinoflagellate is common in brackish estuarine waters.
1989	Environmental management commission gives supplemental classification of Nutrients Sensitive Waters to the entire Tar-Pamlico basin.
June 1988	Pamlico Emergency Response Team (PERT) established in Washington, N.C. Consists of two staffers from DEM and two from the Division of Marine Fisheries (DMF) to respond to environmental concerns in the Tar-Pamlico estuary, due to

complaints of diseased fish and fish kills. The team investigates 41 fish kills and 34 fish disease reports. Notes that the fish kills are centered in spring and fall.

- February 1988 State Environmental Management Commission designates the Neuse River Basin as Nutrient Sensitive Waters and develops strategy to reduce nutrient loadings in the river.
- January 1988 N.C. Division of Environmental Management (DEM) biologists looked at water samples from Dr. Noga and find a large number of dinoflagellates in the sample. No identifying name is assigned to these dinoflagellates.
- N.C. Phosphate ban goes into effect, limiting the amount of phosphates allowed in household detergents. (Tests show the ban resulted in a 50 percent reduction of phosphorous from point sources.)
- 1987 Noga and others report on a disease monitoring program established in the Tar-Pamlico River to assess the occurrence and species distribution of ulcerative mycosis. They trawled the area from May 1985-April 1987 and cast net in Oct/Nov 1986. They collected 70,000 fish of 31 species. Lesions were most common in Atlantic Menhaden, with 15.7 percent of them bearing lesions. Outbreaks appeared to occur in spring and fall.
- 1987 The Albemarle-Pamlico Estuary Study (APES), a cooperative effort between N.C. and the U.S. EPA to better understand and characterize the environmental conditions in the APES region, is launched. Over time, APES will fund millions of dollars worth of studies.
- 1986 Working in N.C. estuaries, Dr. Ed Noga and others find oomycete fungi in early stages of sores. The fish sore disease is named ulcerative mycosis. The scientists also report that an environmental stressor may be initiating the lesions. They also find that the problem occurs in low salinity waters, usually bays and sounds.
- 1978 First recorded instances of Atlantic menhaden with distinct lesions from Chesapeake Bay to Florida, including North Carolina waters.





**BULLETED SUMMARY OF CONFERENCE COMMITTEE
SUBSTITUTE FOR HOUSE BILL 515
CLEAN WATER/ENVIRONMENTALLY SOUND POLICY ACT**

August 25, 1997

Prepared by:
Jeff Hudson, Staff Attorney

PART I. MORATORIA ON CONSTRUCTION OR EXPANSION OF SWINE FARMS

- Establishes a moratorium, beginning March 1, 1997 and ending March 1, 1999, on the construction or expansion of swine farms, lagoons, and animal waste management systems for swine farms (250 or more swine).
- Establishes a moratorium, beginning January 1, 1997 and ending March 1, 1999 on the construction or expansion of swine farms and lagoons in a county that:
 - Has a population of less than 75,000
 - Has over \$150 million on expenditures for travel and tourism
 - Is not in the coastal area.
- Requires that the Environmental Management Commission (EMC) issue only individual permits for animal waste management systems in any county that:
 - Has a population of less than 75,000
 - Has over \$150 million on expenditures for travel and tourism
 - Is not in the coastal area.

PART II. AGRICULTURAL ZONING BY COUNTIES

- Authorizes counties to adopt zoning regulations for swine farms served by an animal waste management system having a design capacity of 600,000 pounds steady state live weight (SSLW) or more.

PART III. CONTROL OF ODOR EMISSIONS FROM ANIMAL OPERATIONS

- Requires the EMC to adopt economically feasible standards to control the emission of odors from animal operations (swine, cattle, horses, sheep, and poultry) by March 1, 1999.

PART IV. SWINE FARM SITING ACT AMENDMENTS

- Establishes additional setbacks for a swine house or lagoon that is a component of a swine farm as follows:
 - At least 2,500 feet from any outdoor recreational facility, national park, State park, historic property, or child care center
 - At least 500 feet from any well supplying water to a public water system
 - At least 500 feet from any other well that supplies water for human consumption.
- Increases the setback for a sprayfield from at least 50 feet to at least 75 feet from:
 - Any property boundary on which an occupied residence is located
 - Any perennial stream or river, other than an irrigation ditch or canal.

- Prohibits the construction of any component of a liquid animal waste management system serving an animal operation, other than a land application site, on land that is located within the 100-year floodplain.

PART V. PRIORITY FOR LOANS OR GRANTS FROM THE CLEAN WATER REVOLVING LOAN AND GRANT FUND TO ASSIST LOCAL GOVERNMENTS IN MEETING THE NITROGEN AND PHOSPHOROUS LIMITS FOR SURFACE WATERS; PRIORITY FOR FUNDING FROM VARIOUS FUNDING SOURCES BASED ON COMPREHENSIVE LAND USE PLANNING BY LOCAL GOVERNMENTS

- Adds the following factors to the current priority criteria for receiving a loan or grant under the Clean Water Revolving Loan and Grant Fund:
 - Existence of a comprehensive land-use plan
 - The comprehensive land-use plan exceeds minimum State water quality standards
 - The comprehensive land-use plan is implemented.
- Directs the EMC to establish priority criteria for modifications to wastewater treatment facilities that must meet new nitrogen and phosphorous limits.

PART VI. NITROGEN AND PHOSPHOROUS LIMITS FOR SURFACE WATERS

- Prohibits facilities that discharge into Nutrient Sensitive Waters from discharging more than an amount of nitrogen than would result from a discharge of the permitted flow with a concentration of 5.5 milligrams of nitrogen per liter. It also prohibits facilities that discharge into nutrient sensitive waters where phosphorous is a nutrient of concern from discharging more than an amount of phosphorous than would result from a discharge of the permitted flow with a concentration of 2.0 milligrams of phosphorous per liter. These nitrogen and phosphorous limits applies only to:
 - Facilities placed into operation prior to July 1, 1997 (or for which an authorization to construct was issued prior to July 1, 1997) and that have a design capacity to discharge 500,000 gallons per day or more.
 - Facilities for which an authorization to construct is issued on or after July 1, 1997
- Allows facilities subject to the nitrogen/phosphorous discharge limits to form cooperative agreements, increase nutrient concentration at a decreased flow, and make adjustments based on modeling in order to satisfy the nitrogen/phosphorous discharge limits.
- Authorizes a civil penalty up to \$10,000 per violation per day for violations of the nitrogen/phosphorous discharge limits.
- Directs the EMC to develop a 5 year phase-in schedule during which facilities must come into compliance with the nitrogen/phosphorous discharge limits.

PART VII. STORMWATER MANAGEMENT

- Directs the EMC to develop model stormwater management programs that may be implemented by State agencies and units of local government.
- Directs the Department of Transportation (DOT) to work with the Division of Water Quality, Department of Environment, Health, Natural Resources (DEHNR), to complete the development of a Statewide stormwater management permit to govern all programs administered by DOT. This permit is to be issued no later than October 1, 1997.

PART VIII. COMPLETION OF BASINWIDE WATER QUALITY MANAGEMENT PLANS FOR EACH OF THE STATE'S SEVENTEEN RIVER BASINS; ADDITIONAL REQUIREMENTS FOR BASINWIDE WATER QUALITY MANAGEMENT PLANS; ADOPTION OF POLLUTANT LIMITS FOR EACH RIVER BASIN

- Directs the EMC to develop and implement a basinwide water quality management plan for each of the State's 17 major river basins. In the development and implementation of these plans, the cumulative impacts of all activities across a river basin and all point and nonpoint sources of pollutants will be considered. Each plan will:
 - Provide that all point and nonpoint sources share responsibility in reducing pollutants in the State's waters in a fair, reasonable, and proportionate manner
 - Establish a nutrient reduction goal in Nutrient Sensitive Waters so that the designated uses of these Waters are not impaired.
- Directs the EMC to adopt total maximum daily loads of pollutants for impaired waters as required by federal law and to incorporate those total maximum daily loads into the Commission's continuing basinwide water quality planning process.

PART IX. CLARIFICATION THAT THE ENVIRONMENTAL MANAGEMENT COMMISSION MAY REQUIRE INDIVIDUAL AS WELL AS GENERAL PERMITS FOR ANIMAL WASTE MANAGEMENT SYSTEMS.

- Clarifies that a person must obtain a permit under either Part 1 (individual permits) or Part 1A (general permits) of Article 21 (Water and Air Resources) in order to construct or operate an animal waste management system.
- Adds the following language to G.S. 143-215.10C(a) regarding the permitting of animal waste management systems: "It is the intent of the General Assembly that most animal waste management systems be permitted under a general permit issued under this Part. The Commission, in its discretion, may require that an animal waste management system be permitted under an individual permit issued under Part 1 of this Article if the Commission determines that an individual permit is necessary to protect water quality, public health, or the environment."

PART X. GRADUATED VIOLATION POINTS SYSTEM FOR SWINE OPERATORS; STUDY OF SWINE INTEGRATORS CIVIL PENALTY LIABILITY.

- Directs the EMC to develop a Violation Points System applicable to permits for animal waste management systems for swine farms, which must include an appeals process.
- Directs DEHNR to develop a recommended system of civil penalties applicable to integrators of swine operations.

PART XI. CRIMINAL ENFORCEMENT FOR REPEATED VIOLATIONS; CLARIFICATION OF REQUIREMENT THAT PERMIT APPLICANTS DEMONSTRATE THAT THEY ARE FINANCIALLY QUALIFIED

- Directs the Secretary of Environment, Health, and Natural Resources to refer to the State Bureau of Investigation for review any discharge of waste by any person or facility in any manner that violates State law related to water and air resources that involves the possible commission of a felony

- Authorizes the EMC to require that applicants for a permit for a privately owned treatment works that serves 15 or more service connections or that regularly serves 25 or more individuals demonstrate that the applicant is and will remain financially qualified to carry out the activity for which the permit is required.

PART XII. ADDITIONAL STUDIES.

- Directs the Environmental Review Commission (ERC) to study the feasibility and desirability of requiring persons who apply soil enriching nutrients onto land to be certified under a certification and training program.
- Directs the Department of Agriculture to submit the next North Carolina Turfgrass Survey to ERC within one month of the survey's publication.
- Directs ERC to study the development of guidelines for best management practices for golf courses.
- Directs the Department of Agriculture to develop a plan to phase out the use of anaerobic lagoons and sprayfields as primary methods of disposing of animal waste at swine farms.
- Directs the Utilities Commission, the Local Government Commission, and EMC to study issues relating to publicly owned treatment works that persistently fail to comply with State and federal water quality laws.

PART XIII. MISCELLANEOUS PROVISIONS: EFFECTIVE DATES

**HIGHLIGHTS OF
HB 1097 - FISHERIES REFORM ACT OF 1997**

(Session Law 1997-400)
Enacted August 14, 1997

The General Assembly recognizes

- The State of North Carolina has one of the most diverse fisheries in the United States;
- That commercial fishermen perform an essential function by providing wholesome food for the citizens of the State and thereby properly earn a livelihood;
- The economic contribution and important heritage of commercial fishing;
- That for many citizens, fishing is an important recreational activity and that recreational fishing is a source of great personal enjoyment and satisfaction;
- The importance of plentiful fisheries resources to maintain and enhance tourism in the State;
- The need to protect our coastal fisheries resources and to balance commercial and recreational interests.

Division of Marine Fisheries Performance Audit

The State Auditor will

- Conduct a performance audit of the Division of Marine Fisheries and assess the capacity of the Division of Marine Fisheries to effectively implement the licensing provisions of the Fisheries Reform Act of 1997.
- Report to the Joint Legislative Commission on Seafood and Aquaculture by February 1, 1998.

Seafood and Aquaculture will review the performance audit and make a specific recommendation to the 1998 General Assembly as to whether the licensing provisions should be implemented.

Joint Legislative Commission on Seafood & Aquaculture Studies

Seafood & Aquaculture will study the following issues and report to the 1998 Regular Session of the General Assembly:

- If and how a recreational saltwater fishing license should be implemented;
- Whether a crew license should be established;
- Development of a comprehensive approach for the enhancement and management of shellfish resources;
- Whether a limited shellfish license or an exemption from shellfish license requirements should be established to allow students under the age of 18 to take and sell shellfish during the summer months;
- Establishment of a comprehensive State program to acquire, preserve and restore critical habitats;
- Procedures and rules used by the License Appeals Panel and requires the License Appeals Panel to submit a detailed summary of its activities to Seafood and Aquaculture.

The Cochair of Seafood and Aquaculture will also appoint an Advisory Committee to aid them in the development of recommendations on issues related to marine fisheries.

Marine Fisheries Commission (MFC)

Effective July 1, 1997, the Marine Fisheries Commission (MFC) membership is reduced from 17 to 9 members appointed by the Governor and comprised of:

- two persons actively engaged in, or recently retired from, commercial fishing;
- one person actively connected with, and experienced as, a licensed fish dealer or seafood processor;
- two persons actively engaged in recreational sports fishing;
- one person actively engaged in the sports fishing industry;
- two persons having general knowledge of and experience related to subjects and persons regulated by the MFC; and,
- one person who is a fisheries scientist.
- At least 5 members must be residents of a coastal region of the State;
- Ethical standards are strengthened;
- Allows the MFC to adopt temporary rules to comply with fisheries management plans adopted by interstate fisheries management councils;
- Establishes 4 standing advisory committees comprised of commercial and recreational fishermen, scientists, and other experts:
 1. Finfish Committee
 2. Crustacean Committee
 3. Shellfish Committee
 4. Habitat & Water Quality Committee
- Establishes 4 regional advisory committees representing the different regions of the State.

Coastal Habitat Protection Plans (CHPP)

Plan Development: The Department of Environment, Health, and Natural Resources will coordinate the preparation of draft Coastal Habitat Protection Plans (CHPPs) for critical fisheries habitats. The goal of the Plans will be the long-term enhancement of coastal fisheries. A CHPP must:

- Describe and classify biological systems in habitats;
- Evaluate the function, value to coastal fisheries, status, and trends of habitats;
- Identify existing and potential threats to habitats and impacts on coastal fishing; and
- Make recommendations to protect and restore critical fisheries habitats.

Plan Adoption: Once a draft CHPP has been prepared, the MFC, Environmental Management Commission (EMC), and Coastal Resources Commission (CRC) must appoint a six-member review committee to review and revise the draft CHPP. The CHPP will then be submitted to each commission to consider for adoption. The commissions may appoint a six-member conference committee to facilitate the resolution of any aspect of a CHPP on which they cannot agree. The final CHPP will consist of the provisions concurrently agreed upon by all three commissions. Each CHPP must be reviewed and revised at least once every five years. Each

commission must, to the maximum extent practicable, ensure that its actions are consistent with the CHPPs and must provide a written explanation of any action it takes that is inconsistent with a CHPP. Any rules adopted to implement the CHPPs must be done in accordance with the Administrative Procedure Act (APA).

The CHPPs must be adopted by July 1, 2003.

Reports: The three commissions must report annually to the ERC and Seafood and Aquaculture on progress and implementation of CHPPs. The Secretary of Environment, Health, and Natural Resources must report to the ERC and Seafood and Aquaculture within 30 days of the completion, or substantial revision of the CHPPs, and the ERC and Seafood and Aquaculture have 30 days to concurrently review and comment.

Fishery Management Plans (FMP)

Plan Development & Adoption: The Department of Environment, Health, and Natural Resources will prepare proposed Fishery Management Plans (FMPs) for adoption by the Marine Fisheries Commission for all commercially or recreationally significant species or fisheries that comprise State marine or estuarine resources. The FMPs will be developed in accordance with a Priority List, Schedule, and guidance criteria established by MFC. The FMPs must incorporate:

- Fishery habitat and water quality considerations consistent with CHPPs;
- Recommended management actions; and
- Conservation and management measures.

Any rules adopted to implement a FMP must be done in accordance with the APA. Advisory Councils composed of experts on each particular fishery will assist in the development of the FMPs.

Reports: The Secretary of Environment, Health and Natural Resources (SEHNR) will monitor the progress of development and adoption of FMPs and will report annually to the ERC and Seafood and Aquaculture on this progress. The SEHNR will also report to Seafood and Aquaculture and the ERC within 30 days of the completion or substantial revision of the FMPs, and Seafood and Aquaculture and the ERC will have 30 days to concurrently review and comment.

Marine Fisheries Law Enforcement

Effective September 1, 1997, the following penalties are increased to Class A1 misdemeanors:

- Violation of general fisheries laws;
- Unlawful sale or purchase of fish which includes an authorization for the SEHNR to assess a civil penalty up to \$10,000 for illegal sale or purchase of fish.

The Fisheries Director is authorized to determine, on a case-by-case basis and in the Director's sole discretion, that a proclamation suspending or implementing any MFC rules did not apply to a licensee who was without notice due to an act of God or unforeseeable circumstance.

The Marine Fisheries Commission will develop a Violations Points System and implementation schedule applicable to the fishing licenses of persons who violate marine fisheries statutes or rules. The MFC will report to Seafood and Aquaculture by July 1, 1999 on the development of the Violation Points System and the implementation schedule.

Commercial Fishing Licenses

No earlier than April 1, 1999, the Marine Fisheries Commission must adopt new rules to implement the commercial fishing license provisions.

Standard Commercial Fishing Licenses (SCFLs):

- Entitle holder to sell fish;
- Are not required for a crew member of a vessel engaged in a commercial fishing operation under the direction of a person holding a SCFL or Retired SCFL;
- Cost \$200 for residents; \$800 for nonresidents or the amount charged to a NC resident in the nonresident's state, whichever is less; however, a nonresident's fee may never be less than \$200;
- Are assignable. Vessel endorsements may be assigned independently of SCFL to another SCFL holder;
- Are transferable under certain circumstances to a member of the SCFL holder's estate; a third-party purchaser of the SCFL holder's fishing vessel; or as authorized by MFC; and
- Vessel endorsements are required for an additional fee based on length of vessel.

Other Commercial Fishing Licenses

- Retired SCFL available to persons 65 and older for an annual fee of \$100 for residents; \$800 for nonresidents or the amount charged to a NC resident in the nonresidents state; however, a nonresident's fee may never be less than \$100;
- Shellfish license for NC residents not holding a SCFL available for \$25;
- Fish dealer license available for various fees; and

Issuance of Fishing Licenses Prior to the Adoption of All Fishery Management Plans (FMPs):

The following applies to the issuance of fishing licenses until all FMPs have been adopted:

- Eligibility - SCFLs are available to any person who holds an Endorsement to Sell on July 1, 1999;
- Flexibility for new entrants - 500 SCFLs will be available for distribution by lot to persons not otherwise eligible for a SCFL;
- Establishment of a temporary cap on the total number of SCFLs the MFC may issue. The temporary cap is equal to the total number of endorsements to sell that establish eligibility for a SCFL plus the additional 500 SCFLs for new entrants;
- For the 1999-2000 license year, the MFC is authorized to:
 - issue an SCFL to any person who held a valid endorsement to sell fish prior to July 1, 1999; and
 - distribute an additional 500 SCFLs by lot.
- For subsequent license years, the MFC is authorized to issue licenses from the pool of available SCFLs. (The pool of available SCFLs is the temporary cap less the number of SCFLs renewed from the previous license year.)

Recreational Commercial Gear License (RCGL)

- RCGL holder may use limited amounts of commercial gear;
- License holder is not entitled to sell fish; and
- Fees: \$35 for residents; \$250 for nonresidents.

By July 1, 1999, the MFC will adopt rules authorizing the use of a limited amount of commercial gear for recreational fishing.

Laws Concerning Crabs

- Moratorium on the issuance of crab licenses is extended until July 1, 1999;
- The MFC must adopt a blue crab Fishery Management Plan by January 1, 1999; and
- Only those persons currently holding crab licenses may take crabs.

Endorsement to Sell Moratorium and Transfer

- The moratorium on the issuance of an endorsement to sell fish on a vessel license is effective August 14, 1997.
- The transfer of an endorsement to sell is transferable in certain circumstances, including the sale of the vessel.

Moratorium Extensions

Moratoriums on the issuance of the following types of licenses are extended to July 1, 1999:

- Consolidated licenses for vessels, equipment, and operations; fees
- Crab License
- Shellfish License
- Endorsement to sell fish

Core Sound Shellfish Leases

The moratorium on new shellfish cultivation leases in a portion of Core Sound is extended to July 1, 1998.



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MEMORANDUM

August 8, 1996

TO: Interested Parties

FROM: Sherri Evans-Stanton, Attorney 

SUBJECT: Summary of Clean Water Management Trust Fund

Section 27.6 of House Bill 35 adds a new "Article 13A" to Chapter 113 of the General Statutes to establish a "Clean Water Management Trust Fund". The Fund will be administered by an independent, statewide Board of Trustees. A detailed summary follows:

G.S. 113-145.1. Purpose. The purpose of the Fund is to help finance projects that address water pollution problems and focus on upgrading surface waters, eliminating pollution, and protecting and conserving unpolluted surface waters, including urban drinking water supplies. In addition to the environmental and recreational benefits, the General Assembly believes that these efforts will enhance wildlife and marine fisheries habitats in this State.

G.S. 113-145.2. Definitions. This section defines various terms.

G.S. 113-145.3. Water Quality Protection and Conservation Trust Fund: established. This section establishes the Fund in the Secretary of State's Office as a nonreverting fund. Money from the Fund may be used for the following purposes:

1. To acquire land for riparian buffers and to establish a network of greenways for environmental, educational, and recreational use.
2. To acquire conservation easements or other interests in real property.
3. To coordinate with other programs to gain the most public benefit while protecting and improving water quality.
4. To restore previously degraded lands.
5. To repair failing waste treatment systems if an application has been submitted to receive a loan or grant from the Clean Water Revolving Loan and Grant Fund and was denied and the repair is not for the purpose of expanding the system to accommodate future growth with a priority given to economically distressed local governments.

6. To repair and eliminate failing septic tank systems, and illegal drainage connections with a priority in funding to economically distressed local governments.
7. To improve stormwater controls and management practices.
8. To facilitate planning that targets reductions in surface water pollution.
9. To fund operating expenses of the Board of Trustees, not to exceed 2% of the budget (or \$850,000, whichever is less).

G.S. 113-145.4. Clean Water Management Trust Fund: eligibility for grants; matching funds or property requirement. Applicants for grants may include: State agencies; a local government or political subdivision of the State; or a nonprofit corporation whose primary purpose is the conservation, preservation, and restoration of State environmental and natural resources. The Board of Trustees may require a match of up to 20% of the amount of the grant awarded.

G.S. 113-145.5. Clean Water Management Trust Fund: Board of Trustees established; membership qualifications; vacancies; meetings and meeting facilities. The Board of Trustees shall be composed of 18 members (six appointed by the Governor, six by the President Pro Tempore of the Senate and six by the Speaker of the House of Representatives). Members shall be appointed to staggered four-year terms. Trustees shall meet at least twice a year and shall receive the per diem, subsistence expenses, and travel expenses as provided by statute.

G.S. 113-145.6. Clean Water Management Trust Fund Board of Trustees: powers and duties. The Board of Trustees shall develop criteria for awarding grants that include:

1. The significant enhancement and conservation of water quality.
2. The objectives of basinwide management plans for river basins.
3. The promotion of regional integrated ecological networks.
4. The specific areas targets as being environmentally sensitive.
5. The geographic distribution of funds as appropriate.
6. The preservation of water resources with significant recreational value and uses.
7. The development of a network of greenways bordering and connecting the State's waterways that will serve environmental, educational, and recreational uses.

G.S. 113-145.7. Clean Water Management Trust Fund: Executive Director and staff. The Board of Trustees shall hire an Executive Director, who shall serve at the pleasure of the Board. Subject to approval by the Board, the Executive Director may employ additional clerical and other assistants, as necessary.

G.S. 113-145.8. Clean Water Management Trust Fund: Advisory Council. The Advisory Council is composed of the following: (1) Commissioner of Agriculture; (2) Chair of the Wildlife Resources Commission; (3) Secretary of Environment, Health, and Natural Resources, and (4) Secretary of Commerce. The Advisory Council shall advise the Board of Trustees with regard to allocations made from the Fund.

In addition, a new section has been added to Chapter 143 of the General Statutes (State Depts., Institutions, and Commissions). G.S. 143-15.3B will establish the Clean Water Management Trust Fund and will direct the State Controller to reserve 6.5% of any unreserved credit balance remaining in the General Fund at the end of each fiscal year for this Fund.

For the 1996-97 fiscal year only, \$9,200,000 of the approximate \$39,900,000 shall be transferred to the Wetlands Restoration Fund to implement that program.

The provision became effective on June 30, 1996.

North Carolina Clean Water Management Trust Fund Board of Trustees

03-Dec-96

Membership: 18 - 6 by Governor

Chairman: by Governor

Term Length 4

Cite: General Statute 113-145.5

Department: Environment, Health and Natural Resources

Ethics: Y

Purpose:

To provide funds to clean up pollution in the state's surface waters and to protect and conserve those waters not yet polluted. The Board shall allocate grant funds, develop grant criteria and guidelines, acquire, exchange, and manage land.

Hester, Joseph M. Mr., Jr.	County: Nash	Date Appt: 11/12/96	Term Exp: 12/31/2002
Call Name: Joe			
P. O. Box 2626	Home: (919) 443-1609		
Rocky Mount NC 27802	Business: (919) 977-1911		
Position: 1 Chairman	Appointed by: Governor		
Description: At-large	Race: Caucasian	Sex: M	
 Ansbacher, Caroline B. Ms.	County: Alamance	Date Appt: 11/12/96	Term Exp: 12/31/2002
Call Name: Caroline			
1132 W. Davis Street	Home: (910) 226-8214		
Burlington NC 27215	Business: (910) 228-7100		
Position: 2 Member	Appointed by: Governor		
Description: At-large	Race: Caucasian	Sex: F	
 Hagan, John C. Mr.	County: Guilford	Date Appt: 11/12/96	Term Exp: 12/31/2000
Call Name: John			
506 Country Club Drive	Home: (910) 274-2044		
Greensboro NC 27408	Business: (910) 337-1985		
Position: 3 Member	Appointed by: Governor		
Description: At-large	Race: Caucasian	Sex: M	
 Vacant	County:	Date Appt:	Term Exp:
Call Name:			
	Home:		
	Business:		
Position: 4 Member	Appointed by: Governor		
Description: At-large	Race:	Sex:	
 Costlow, John D. Dr.	County: Carteret	Date Appt: 11/12/96	Term Exp: 12/31/98
Call Name: John			
201 Ann Street	Home: (919) 728-4027		
Beaufort NC 28516	Business:		
Position: 5 Member	Appointed by: Governor		
Description: At-large	Race: Caucasian	Sex: M	

Croom, Donell Mr. Call Name: Don 4009 Waldenbrook Road Greensboro NC 27407 Position: 6 Member Description: At-large	County: Guilford Date Appt: 11/12/96 Term Exp: 12/31/98 Home: (910) 855-6989 Business: (910) 273-2707 Appointed by: Governor Race: African American Sex: M
Hollan, William E. Mr., Jr. Call Name: Bill 710 - G Coliseum Drive Winston - Salem NC 27106 Position: 7 Member Description: At-large	County: Forsyth Date Appt: 10/4/96 Term Exp: 12/31/2002 Home: Business: (910) 722-2236 Appointed by: Senate Pro-Tem Race: Caucasian Sex: M
Wright, Jerry W. Mr. Call Name: Jerry P. O. Box 252 Jarvisburg NC 27947 Position: 8 Member Description: At-large	County: Currituck Date Appt: 10/4/96 Term Exp: 12/31/2002 Home: (919) 491-8303 Business: (919) 491-8402 Appointed by: Senate Pro-Tem Race: Caucasian Sex: M
Johns, Elizabeth B. Ms. Call Name: Bunny Nantabala Outdoor Center 13077 Highway 19 W Bryson City NC 28713 Position: 9 Member Description: At-large	County: Swain Date Appt: 10/4/96 Term Exp: 12/31/2000 Home: Business: Appointed by: Senate Pro-Tem Race: Caucasian Sex: F
Mc Lean, Dickson Mr., Jr. Call Name: Dickson P. O. Drawer 1087 Lumberton NC 28359 Position: 10 Member Description: At-large	County: Robeson Date Appt: 10/4/96 Term Exp: 12/31/2000 Home: Business: Appointed by: Senate Pro-Tem Race: Caucasian Sex: M
Bryant, Ronald Owen Mr. Call Name: Ronald 1100 Ardsley Road Charlotte NC 28207-1818 Position: 11 Member Description: At-large	County: Mecklenburg Date Appt: 10/4/96 Term Exp: 12/31/98 Home: Business: Appointed by: Senate Pro-Tem Race: Caucasian Sex: M

Hardison, Allen M. Mr. Call Name: Allen P. O. Box 204 Snow Hill NC 28580 Position: 12 Member Description: At-large	County: Greene Home: Business: Appointed by: Senate Pro-Tem Race: Caucasian Sex: M	Date Appt: 10/4/96 Term Exp: 12/31/98
Gwyn, Allen Holt Mr. Call Name: Holt P. O. Box 20004 Greensboro NC 27420 Position: 13 Member Description: At-large	County: Guilford Home: Business: Appointed by: Speaker of the House Race: Sex: M	Date Appt: 11/27/96 Term Exp: 12/31/2002
Wakild, Chuck Mr. Call Name: Chuck 6325 Myrtle Grove Road Wilmington NC 28409 Position: 14 Member Description: At-large	County: New Hanover Home: Business: Appointed by: Speaker of the House Race: Sex: M	Date Appt: 11/27/96 Term Exp: 12/31/2002
Howard, Robert D. Mr. Call Name: Bob P. O. Box 723 Whiteville NC 28472 Position: 15 Member Description: At-large	County: Columbus Home: Business: Appointed by: Speaker of the House Race: Sex: M	Date Appt: 11/27/96 Term Exp: 12/31/2000
Willis, Drew Mr. Call Name: Drew P. O. Box 12009 New Bern NC 28561 Position: 16 Member Description: At-large	County: Craven Home: Business: Appointed by: Speaker of the House Race: Sex: M	Date Appt: 11/27/96 Term Exp: 12/31/2000
Cragolin, Karen Ms. Call Name: Karen 7 Cedarcliff Road Asheville NC 28803 Position: 17 Member Description: At-large	County: Beaufort Home: Business: Appointed by: Speaker of the House Race: Sex: F	Date Appt: 11/27/96 Term Exp: 12/31/98

Prescott, Phil Mr.	County: Pamlico	Date Appt: 11/27/96	Term Exp: 12/31/98
Call Name: Phil			
P. O. Box 435	Home:		
Bayboro NC 28515	Business:		
Position: 18 Member	Appointed by: Speaker of the House		
Description: At-large	Race:		Sex: M

"u. To administer the State's authority under 33 USC § 1341 of the federal Clean Water Act."

(c) The Department of Environment, Health, and Natural Resources is directed to negotiate and enter into a Memorandum of Agreement with the United States Army Corps of Engineers regarding the restoration, creation, enhancement, and preservation of wetlands and the compensatory mitigation required of permit applicants under 33 U.S.C. § 1344. The purpose of the Memorandum of Agreement is to ensure that the State's implementation of the Wetlands Restoration Program with regard to mitigation of wetlands satisfies the United States Army Corps of Engineers and that the standards developed by the State to which the State's and other mitigation banks must adhere is acceptable to the Corps for purposes of section 404 mitigation requirements.

(d) Of the funds appropriated to the Department of Environment, Health, and Natural Resources, the sum of five hundred thousand dollars (\$500,000) in recurring funds for the 1996-97 fiscal year shall be allocated to support eight staff positions and for administrative and other expenses to implement the Wetlands Restoration Program.

(e) The Environmental Review Commission shall study private mitigation banks. In its study the Environmental Review Commission shall compare private mitigation banks with the Wetlands Restoration Program and may also consider any additional issues relevant to those topics. The Environmental Review Commission shall report to the 1997 General Assembly regarding its findings and recommendations.

Requested by: Senators Basnight, Perdue, Odom, Plyler, Martin of Pitt, Jordan, Kerr, Representatives Holmes, Creech, Esposito, Mitchell, Weatherly, Nichols
CLEAN WATER MANAGEMENT TRUST FUND

Sec. 27.6. (a) Chapter 113 of the General Statutes is amended by adding a new Article to read:

"ARTICLE 13A.

"Clean Water Management Trust Fund.

"§ 113-145.1. Purpose.

The General Assembly recognizes that a critical need exists in this State to clean up pollution in the State's surface waters and to protect and conserve those waters that are not yet polluted. The task of cleaning up polluted waters and protecting the State's water resources is multifaceted and requires different approaches that take into account the problems, the type of pollution, the geographical area, and the recognition that the hydrological and ecological values of each resource sought to be upgraded, conserved, and protected are unique.

It is the intent of the General Assembly that moneys from the Fund created under this Article shall be used to help finance projects that specifically address water pollution problems and focus on upgrading surface waters, eliminating pollution, and protecting and conserving unpolluted surface waters, including urban drinking water supplies. It is the further intent of the General Assembly that moneys from the Fund also be used to build a network of riparian buffers and greenways for environmental, educational, and recreational benefits. While the purpose of this Article is to focus on the cleanup and prevention of pollution of the State's surface waters and the establishment of a network of riparian buffers and greenways, the General Assembly believes that the results of these efforts will also be beneficial to wildlife and marine fisheries habitats.

"§ 113-145.2. Definitions.

As used in this Article:

- (1) Council -- The advisory council for the Clean Water Management Trust Fund.
- (2) Economically Distressed Units of Local Government -- Counties designated as economically distressed by the Secretary of Commerce under G.S. 143B-437A and any cities located in those counties.
- (3) Fund -- The Clean Water Management Trust Fund created pursuant to this Article.
- (4) Land -- Real property and any interest in, easement in, or restriction on real property.
- (5) Trustees -- The trustees of the Clean Water Management Trust Fund.

"§ 113-145.3. Clean Water Management Trust Fund: established.

(a) Fund Established -- There is established a Clean Water Management Trust Fund in the State Treasurer's Office that shall be used to finance projects to clean up or prevent surface water pollution in accordance with this Article.

(b) Fund Earnings, Assets, and Balances -- The State Treasurer shall hold the Fund separate and apart from all other moneys, funds, and accounts. Investment earnings credited to the assets of the Fund shall become part of the Fund. Any balance remaining in the Fund at the end of any fiscal year shall be carried forward in the Fund for the next succeeding fiscal year. Payments from the Fund shall be made on the warrant of the Chair of the Board of Trustees.

(c) Fund Purposes -- Moneys from the Fund may be used for any of the following purposes:

- (1) To acquire land for riparian buffers for the purposes of providing environmental protection for surface waters and urban drinking water supplies and establishing a network of riparian greenways for environmental, educational, and recreational uses.
- (2) To acquire conservation easements or other interests in real property for the purpose of protecting and conserving surface waters and urban drinking water supplies.
- (3) To coordinate with other public programs involved with lands adjoining water bodies to gain the most public benefit while protecting and improving water quality.
- (4) To restore previously degraded lands to reestablish their ability to protect water quality.
- (5) To repair failing waste treatment systems if: (i) an application has first been submitted to receive a loan or grant from the Clean Water Revolving Loan and Grant Fund and the application was denied during the latest review cycle; (ii) the repair is a reasonable remedy for resolving an existing waste treatment problem; and (iii) the repair is not for the purpose of expanding the system to accommodate future anticipated growth of a community. Priority shall be given to economically distressed units of local government.
- (6) To repair and eliminate failing septic tank systems, to eliminate illegal drainage connections, and to expand waste treatment systems if the system is being expanded as a remedy to eliminate failing septic tank systems or illegal drainage connections. Priority shall be given to economically distressed units of local government.
- (7) To improve stormwater controls and management practices.
- (8) To facilitate planning that targets reductions in surface water pollution.
- (9) To fund operating expenses of the Board of Trustees and its staff.

(d) Limit on Operating and Administrative Expenses. -- No more than two percent (2%) of the annual balance of the Fund on July 1 or a total sum of eight hundred fifty thousand dollars (\$850,000), whichever is less, may be used each fiscal year for administrative and operating expenses of the Board of Trustees and its staff.

"§ 113-145.4. Clean Water Management Trust Fund: eligibility for grants; matching funds or property requirement.

(a) Eligible Grant Applicants. -- Any of the following are eligible to apply for a grant from the Fund for the purpose of protecting and enhancing water quality:

- (1) A State agency.
- (2) A local government or other political subdivision of the State or a combination of such entities.
- (3) A nonprofit corporation whose primary purpose is the conservation, preservation, and restoration of our State's environmental and natural resources.

(b) Grant Matching Requirement. -- The Board of Trustees shall establish matching requirements for grants awarded under this Article. The Board of Trustees may require a match of up to twenty percent (20%) of the amount of the grant awarded. This requirement may be satisfied by the donation of land to a public or private nonprofit conservation organization as approved by the Board of Trustees. The Board of Trustees may also waive the requirement to match a grant pursuant to guidelines adopted by the Board of Trustees.

(c) Grants Not Available to Satisfy Compensatory Mitigation Requirements. -- No grant shall be awarded under this article to satisfy compensatory mitigation requirements under 33 USC § 1344 or G.S. 143-214.11.

"§ 113-145.5. Clean Water Management Trust Fund: Board of Trustees established; membership qualifications; vacancies; meetings and meeting facilities.

(a) Board of Trustees Established. -- There is established the Clean Water Management Trust Fund Board of Trustees. The Clean Water Management Trust Fund Board of Trustees shall be independent, but for administrative purposes shall be located under the Department of Environment, Health, and Natural Resources.

(b) Membership. -- The Clean Water Management Trust Fund Board of Trustees shall be composed of 18 members. Six members shall be appointed by the Governor, six by the General Assembly upon the recommendation of the President Pro Tempore of the Senate in accordance with G.S. 120-121, and six by the General Assembly upon the recommendation of the Speaker of the House of Representatives in accordance with G.S. 120-121. The office of Trustee is declared to be an office that may be held concurrently with any other executive or appointive office, under the authority of Article VI, Section 9, of the North Carolina Constitution.

Persons appointed shall be knowledgeable in one of the following areas:

- (1) Acquisition and management of natural areas.
- (2) Conservation and restoration of water quality.
- (3) Wildlife and fisheries habitats and resources.
- (4) Environmental management.

(c) Initial Appointments. -- Each appointing officer shall designate two of the officer's initial appointments to serve two-year terms, two to serve four-year terms, and two to serve six-year terms. Thereafter, all appointments shall be for four years, subject to reappointment. All initial appointments shall be made on or before January 1, 1997. The Governor shall appoint one Trustee to serve as Chair of the Board.

(d) Vacancies. -- If a vacancy occurs, other than by the expiration of term, of a member subject to appointment by the General Assembly upon the recommendation of the Speaker of the House of Representatives or the President Pro Tempore of the Senate, the vacancy shall be filled in accordance with G.S. 120-122. All other vacancies shall be filled by the appointing official in the original manner.

(e) Frequency of Meetings. -- The Trustees shall meet at least twice each year and may hold special meetings at the call of the Chair or a majority of the members.

(f) Per Diem and Expenses. -- The Trustees shall receive per diem and necessary travel and subsistence expenses in accordance with the provisions of G.S. 138-5. Per diem, subsistence, and travel expenses of the Trustees shall be paid from the Fund.

(g) Meeting Facilities. -- The Secretary of the Department of Environment, Health, and Natural Resources shall provide meeting facilities for the Board of Trustees and its staff as requested by the Chair.

"§ 113-145.6. Clean Water Management Trust Fund Board of Trustees: powers and duties.

(a) Allocate Grant Funds. -- The Trustees shall allocate moneys from the Fund as grants. A grant may be awarded only for a project or activity that satisfies the criteria and furthers the purposes of this Article.

(b) Develop Grant Criteria. -- The Trustees shall develop criteria for awarding grants under this Article. The criteria developed shall include consideration of the following:

- (1) The significant enhancement and conservation of water quality in the State.
- (2) The objectives of the basinwide management plans for the State's river basins and watersheds.
- (3) The promotion of regional integrated ecological networks insofar as they affect water quality.
- (4) The specific areas targeted as being environmentally sensitive.
- (5) The geographic distribution of funds as appropriate.
- (6) The preservation of water resources with significant recreational or economic value and uses.
- (7) The development of a network of riparian buffer-greenways bordering and connecting the State's waterways that will serve environmental, educational, and recreational uses.

(c) Develop Additional Guidelines. -- The Trustees may develop guidelines in addition to the grant criteria consistent with and as necessary to implement this Article.

(d) Acquisition of Land. -- The Trustees may acquire land by purchase, negotiation, gift, or devise. Any acquisition of land by the Trustees must be reviewed and approved by the Council of State and the deed for the land subject to approval of the Attorney General before the acquisition can become effective. In determining whether to acquire land as permitted by this Article, the Trustees shall consider whether the acquisition furthers the purposes of this Article and may also consider recommendations from the Council. Nothing in this section shall allow the Trustees to acquire land under the right of eminent domain.

(e) Exchange of Land. -- The Trustees may exchange any land they acquire in carrying out the powers conferred on the Trustees by this Article.

(f) Land Management. -- The Trustees may designate managers or managing agencies of the lands acquired under this Article.

(g) Tax Credit Certification. -- The Trustees shall develop guidelines to determine whether land donated for a tax credit under G.S. 105-130.34 or G.S. 105-151.12 are suitable for one of the purposes under this Article and may be certified for a tax credit.

(h) Rule-making Authority. -- The Trustees may adopt rules to implement this Article. Chapter 150B of the General Statutes applies to the adoption of rules by the Trustees.

"§ 113-145.7. Clean Water Management Trust Fund: Executive Director and staff.

The Clean Water Management Trust Fund Board of Trustees, as soon as practicable after its organization, shall select and appoint a competent person in accordance with this section as Executive Director of the Clean Water Management Trust Fund Board of Trustees. The Executive Director shall be charged with the supervision of all activities under the jurisdiction of the Trustees and shall serve as the chief administrative officer of the Trustees. Subject to the approval of the Trustees and the Director of the Budget, the Executive Director may employ such clerical and other assistants as may be deemed necessary.

The person selected as Executive Director shall have had training and experience in conservation, protection, and management of surface water resources. The salary of the Executive Director shall be fixed by the Trustees, and the Executive Director shall be allowed travel and subsistence expenses in accordance with G.S. 138-6. The Executive Director's salary and expenses shall be paid from the Fund. The term of office of the Executive Director shall be at the pleasure of the Trustees.

"§ 113-145.8. Clean Water Management Trust Fund: Advisory Council.

There is established the Clean Water Management Trust Fund Advisory Council. The Council shall advise the Trustees with regard to allocations made from the Fund, and other issues as requested by the Trustees. The Council shall be composed of the following or its designees:

- (1) Commissioner of Agriculture.
- (2) Chair of the Wildlife Resources Commission.
- (3) Secretary of the Department of Environment, Health, and Natural Resources.
- (4) Secretary of the Department of Commerce."

(b) Article 1 of Chapter 143 of the General Statutes is amended by adding a new section to read:

"§ 143-15.3B. The Clean Water Management Trust Fund.

(a) The Clean Water Management Trust Fund is established in G.S. 113-145.3. The State Controller shall reserve to the Clean Water Management Trust Fund six and one-half percent (6.5%) of any unreserved credit balance remaining in the General Fund at the end of each fiscal year. As used in this section, the term 'unreserved credit balance' means the credit balance amount, as determined on a cash basis, before funds are reserved by the State Controller to the Savings Reserve Account, the Repairs and Renovations Reserve Account, or the Clean Water Management Trust Fund pursuant to this section, G.S. 143-15.3, and G.S. 143-15.3A.

(b) The funds in the Clean Water Management Trust Fund shall be used only in accordance with Article 13A of Chapter 113 of the General Statutes."

(c) The Chair of the Board of Trustees of the Clean Water Management Trust Fund shall report to the Environmental Review Commission beginning November 1, 1996, and annually thereafter on implementation of this section. A written copy of the report shall also be sent to the Fiscal Research Division of the General Assembly beginning November 1, 1996, and annually thereafter on implementation of this section.

(d) For the 1996-97 fiscal year only, of the funds reserved under G.S. 143-15.3B to the Clean Water Management Trust Fund, the State Controller shall transfer the sum of nine million two hundred thousand dollars (\$9,200,000) to the Wetlands Restoration Fund to be used to implement the Wetlands Restoration Program. The 1997 General Assembly shall review and consider further funding needs of the Wetlands Restoration Program and the Wetlands Restoration Fund for the 1997-98 fiscal year and subsequent years.

(e) This section becomes effective June 30, 1996.

The North Carolina Wetlands Restoration Program

The North Carolina Wetlands Restoration Program (NCWRP) was established by an act of the North Carolina General Assembly in 1996. This action of the General Assembly was the result of a four year cooperative effort of the Divisions of Water Quality and Coastal Management. In addition, the administration of the Department of Environment, Health and Natural Resources and several other Divisions within the Department were instrumental in the establishment of this program. The purpose of the NCWRP is to protect and improve water quality, flood prevention, fisheries, wildlife and plant habitats, and recreational opportunities through the protection and restoration of wetlands and riparian areas.

The NCWRP will accomplish this purpose by restoring wetlands functions and values throughout North Carolina which will result in a net increase in wetlands acres, functions, and values in each of the seventeen river basins. The ecological effectiveness of compensatory mitigation will be improved through the development of restoration plans which will ensure that compensatory mitigation is conducted within an ecosystem context to address identified problems. This proactive approach will provide a consistent and simplified approach to address compensatory mitigation requirements and will foster a comprehensive approach to environmental protection.

Beginning July 1, 1997, comprehensive basinwide wetlands restoration plans will be developed for each river basin in conjunction with the Basinwide Water Quality Management Plans. The GIS-based mapping methodologies developed by the Division of Coastal Management will be used to assess the status of the existing wetlands and riparian area resources within the basin and to identify degraded wetlands and riparian areas. Identified sites will be prioritized based on the ability of the restored sites to address problems that have been identified in the Basinwide Water Quality Management Plans. The restoration plans will provide the framework for the Wetlands Restoration program, therefore it is essential that the public, local governments, state and federal agencies and others be involved in the development of these plans.

The Wetlands Restoration Fund, which is a component of the NCWRP, will provide a repository for appropriations from the General Assembly, monetary contributions, donations of property, payments in lieu of compensatory mitigation requirement and grants. The enabling legislation for the NCWRP restricts the use of these funds to the restoration, enhancement, preservation and creation of wetlands and riparian areas in accordance with the basinwide restoration plans. In addition, this fund may be used for directly related costs of planning, monitoring and maintenance of wetlands and riparian areas. On April 10, 1996, the Environmental

Management Commission adopted temporary rules that established a fee schedule for payments in lieu of compensatory mitigation requirements. The schedule is as follows:

Classified surface waters	\$125/linear foot of stream
Class WL wetlands	
non-riparian	\$12,000/acre
riparian	\$24,000/acre
Class SWL wetlands	\$120,000/acre

A Memorandum of Agreement with the United States Army Corps of Engineers (USACOE) concerning the use of the Fund to address the compensatory mitigation requirements of Section 404 permits is being developed. All agencies that are involved in the 404 permit review permit will be provided the opportunity to participate in the development of this agreement. The Memorandum of Agreement will ensure that the NCWRP will only be available after the applicant has demonstrated that the wetland impacts are unavoidable in accordance with the USACOE review procedures. Recipients of Section 404 permits will not be forced to participate in the NCWRP. However, NCWRP will provide permittees with another option to satisfy the compensatory mitigation requirements. Permittees will continue to be allowed to design and implement their own project, or they may purchase credits from private mitigation banks.

The final component of the NCWRP will be the implementation of projects in accordance with the basinwide restoration plans. Implementation of the plans will occur in several ways including the establishment of private mitigation banks in identified areas, partnerships with local governments, state and federal agencies, land trusts and other non-profit organizations, and when necessary the NCWRP will issue contracts to restore identified areas.

The Divisions of Water Quality and Coastal Management are committed to implementing the NCWRP to achieve the purpose and goals outlined in the enabling legislation. Full implementation of this program will provide benefits to all citizens and regions of North Carolina.

Ron Ferrell
Program Manager
Wetlands Restoration Program
NC Division of Water Quality
P.O. Box 29535
Raleigh, NC 27626-0535

Phone: 919/733-5083 ext. 358
Fax: 919/733-2496
E-mail: ron@dem.ehnr.state.nc.us

State of North Carolina
Department of Environment,
Health and Natural Resources
Division of Water Quality

James B. Hunt, Jr., Governor
Jonathan B. Howes, Secretary
A. Preston Howard, Jr., P.E., Director



April 22, 1997

MEMORANDUM

TO: Interested Parties
FROM: Ron Ferrell *RJF*
SUBJECT: Wetlands Restoration Program
Notice of Permanent Rule-making

Temporary rules were adopted by the Environmental Management Commission on April 10, 1997 establishing the fee schedule for the Wetlands Restoration Fund. The temporary rules will be published in the N.C. Register on May 1, 1997 and will be effective May 6, 1997. Attached is a copy of the temporary rules and a memo summarizing the rules.

The permanent rule-making process has now been initiated. Comments, statements, data, and other information may be submitted in writing by July 1, 1997. Information concerning the rules may be obtained by contacting the Wetlands Restoration Program at (919) 733-5083 ext. 358 or submitting a written request to the address below. Written comments may be submitted to Ron Ferrell, Wetlands Restoration Program, Division of Water Quality, P.O. Box 29535, Raleigh, NC 27626-0535. Interested parties will be notified, and given the opportunity to review any proposed permanent rule before the rule is submitted to the Environmental Management Commission for adoption.

The Wetland Restoration Program has also begun the development of preliminary wetlands restoration plans to guide the use of Fund assets. Development of the plans is the most critical component of the Wetlands Restoration Program. Any restoration work paid for out of the Fund will be carried out at sites identified under the plans as priority sites. Also, donations of real property may be made to the Fund if the site is consistent with and meets the objectives of the restoration plans. We welcome your participation in the development of the restoration plans for each basin. If you or your organization are interested in being involved in the development of the Wetland Restoration Plans, please contact Ron Ferrell at the above address or telephone number.

State of North Carolina
Department of Environment,
Health and Natural Resources
Division of Water Quality

James B. Hunt, Jr., Governor
Jonathan B. Howes, Secretary
A. Preston Howard, Jr., P.E., Director



April 22, 1997

MEMORANDUM

TO: Interested Parties
FROM: Ron Ferrell *RF*
SUBJECT: Wetland Mitigation Requirements and the Wetland Restoration Fund

The North Carolina Wetland Restoration Program was recently established by the North Carolina General Assembly. The Program enables applicants who have been required by the State to perform compensatory wetland mitigation as a condition of a 401 Water Quality Certification, to have the option of making payments to the Wetland Restoration Fund (Fund) in lieu of compensatory mitigation. Currently, participation in the Fund is limited to those permit applicants required to perform compensatory mitigation as a condition of a 401 Water Quality Certification. In the future, applicants who are required to perform compensatory mitigation as a condition of a Section 404 permit issued by the U.S. Army Corps of Engineers may also have the option of participating in the Fund.

Under G.S. 143-214.11 (d) (1)-(4), a permit applicant has the following options to satisfy compensatory mitigation requirements:

1. Payment of a fee established by the Environmental Management Commission into the Wetlands Restoration Fund.
2. Purchase credits from a private wetlands mitigation bank.
3. Preparing and implementing a wetlands restoration plan.
4. Donation of land to the Wetlands Restoration Program or to other public or private nonprofit conservation organizations as approved by the Department.

An applicant who chooses to satisfy their compensatory mitigation requirements under option 1 will be subject to the following fee schedule:

For riparian wetlands: the payment shall be \$24,000 per acre of required mitigation;
For non-riparian wetlands: the payment shall be \$12,000 per acre of required mitigation;
For coastal wetlands: the payment shall be \$120,000 per acre of required mitigation;
For streams: the payment shall be \$125 per linear foot.

The purpose of the Wetland Restoration Program is to restore wetlands across the State, provide a consistent and simplified approach to address compensatory mitigation requirements of State and Federal regulatory programs, streamline the wetlands permitting process, and increase the ecological effectiveness of compensatory mitigation. Funds contributed to the Wetland Restoration Fund will be used for activities directly related to the acquisition, perpetual maintenance, enhancement, restoration, or creation of wetlands and riparian areas in accordance with the basinwide plan.

For more information about the Wetland Restoration Program or the Fund, contact: Mr. Ron Ferrell at (919) 733-5083, ext. 358.

NORTH CAROLINA WETLANDS RESTORATION PROGRAM

§ 143-214.8. Wetlands Restoration Program: established

The Wetlands Restoration Program is established within the Department of Environment, Health, and Natural Resources. The Wetlands Restoration Program shall be developed by the Department as a nonregulatory statewide wetlands restoration program for the acquisition, maintenance, restoration, enhancement, and creation of wetland and riparian resources that contribute to the protection and improvement of water quality, flood prevention, fisheries, wildlife habitat, and recreational opportunities. The Wetlands Restoration Program shall consist of the following components:

- (1) Restoration and perpetual maintenance of wetlands.
- (2) Development of restoration plans.
- (3) Landowner contact and land acquisition.
- (4) Evaluation of site plans and engineering studies.
- (5) Oversight of construction and monitoring of restoration sites.
- (6) Land ownership and management.
- (7) Mapping, site identification, and assessment of wetlands functions.
- (8) Oversight of private wetland mitigation banks to facilitate the components of the Wetlands Restoration Program.

Added by Laws 1996, 2 Ex.Sess., c. 18, § 27.4(a), eff. July 1, 1996.

§ 143-214.9. Wetlands Restoration Program: purposes

The purposes of the program are as follows:

- (1) To restore wetlands functions and values across the State to replace critical functions lost through historic wetlands conversion and through current and future permitted impacts. It is not the policy of the State to destroy upland habitats unless it would further the purposes of the Wetlands Restoration Program.
- (2) To provide a consistent and simplified approach to address mitigation requirements associated with permits or authorizations issued by the United States Army Corps of Engineers under 33 U.S.C. § 1344.
- (3) To streamline the wetlands permitting process, minimize delays in permit decisions, and decrease the burden of permit applicants of planning and performing compensatory mitigation for wetlands losses.
- (4) To increase the ecological effectiveness of compensatory mitigation.
- (5) To achieve a net increase in wetland acres, functions, and values in each major river basin.
- (6) To foster a comprehensive approach to environmental protection.

Added by Laws 1996, 2 Ex.Sess., c. 18, § 27.4(a), eff. July 1, 1996.

§ 143-214.10. Wetlands Restoration Program: development and implementation of basinwide restoration plans

Develop Basinwide Restoration Plans.--The Department shall develop basinwide plans for wetlands and riparian area restoration with the goal of protecting and enhancing water quality, flood prevention, fisheries, wildlife habitat, and recreational opportunities within each of the 17 major river basins in the State. Beginning July 1, 1997, the Department shall develop and begin implementing a basinwide restoration plan for each of the 17 river basins in the State in accordance with the basinwide schedule currently established by the Division of Water Quality.

Added by Laws 1996, 2 Ex.Sess., c. 18, § 27.4(a), eff. July 1, 1996.

§ 143-214.11. Wetlands Restoration Program: compensatory mitigation

- (a) **Definition.**--For purposes of this section, the term "compensatory mitigation" means the restoration, creation, enhancement, or preservation of wetlands or other areas required as a condition of a section 404 permit issued by the United States Army Corps of Engineers.
- (b) **Department of Environment, Health, and Natural Resources to Coordinate Compensatory Mitigation.**--All compensatory mitigation required by permits or authorizations issued by the United States Army Corps of Engineers under 33 U.S.C. § 1344 shall be coordinated by the Department consistent with the basinwide plans for wetlands restoration and rules developed by the Environmental Management Commission. All compensatory wetlands mitigation, whether performed by the Department or by permit applicants, shall be consistent with the basinwide restoration plans.
- (c) **Mitigation Emphasis on Replacing Ecological Function Within Same River Basin.**--The emphasis of mitigation is on replacing functions within the same river basin unless it is demonstrated that restoration of other areas would be more beneficial to the overall purposes of the Wetlands Restoration Program.

(d) Compensatory Mitigation Options Available to Applicant.--An applicant may satisfy compensatory wetlands mitigation requirements by the following actions, if those actions are consistent with the basinwide restoration plans and also meet or exceed the requirements of the United States Army Corps of Engineers:

- (1) Payment of a fee established by the Department into the Wetlands Restoration Fund established in G.S. 143-214.12.
- (2) Donation of land to the Wetlands Restoration Program or to other public or private nonprofit conservation organizations as approved by the Department.
- (3) Participation in a private wetlands mitigation bank.
- (4) Preparing and implementing a wetlands restoration plan.
- (e) Payment Schedule.--A standardized schedule of per-acre payment amounts shall be established by the Environmental Management Commission. The monetary payment shall be based on the ecological functions and values of wetlands permitted to be lost and on the cost of restoring or creating wetlands capable of performing the same or similar functions, including directly related costs of wetlands restoration planning, long-term monitoring, and maintenance of restored areas.
- (f) Mitigation Banks.--State agencies and private mitigation banking companies shall demonstrate that adequate, dedicated financial surety exists to provide for the perpetual land management and hydrological maintenance of lands acquired by the State as mitigation banks, or proposed to the State as privately operated and permitted mitigation banks.

Added by Laws 1996, 2 Ex.Sess., c. 18, s 27.4(a), eff. July 1, 1996.

§ 143-214.12. Wetlands Restoration Program: Wetlands Restoration Fund

(a) Wetlands Restoration Fund.--The Wetlands Restoration Fund is established as a nonreverting fund within the Department. The Fund shall be treated as a special trust fund and shall be credited with interest by the State Treasurer pursuant to G.S. 147-69.2 and G.S. 147-69.3. The Wetlands Restoration Fund shall provide a repository for monetary contributions and donations or dedications of interests in real property to promote projects for the restoration, enhancement, preservation, or creation of wetlands and riparian areas and for payments made in lieu of compensatory mitigation as described in subsection (b) of this section. No funds shall be expended from this Fund for any purpose other than those directly contributing to the acquisition, perpetual maintenance, enhancement, restoration, or creation of wetlands and riparian areas in accordance with the basinwide plan as described in subsection (a) of this section.

(b) Authorized Methods of Payment.--A person subject to a permit or authorization issued by the United States Army Corps of Engineers under 33 U.S.C. s 1344, may contribute to the Wetlands Restoration Program, to comply with conditions to, or terms of, the permit or authorization, if participation in the Wetlands Restoration Program will meet the mitigation requirements of the United States Army Corps of Engineers. The Department shall, at the discretion of the applicant, accept payment into the Wetlands Restoration Fund in lieu of other compensatory mitigation requirements of any authorizations issued by the United States Army Corps of Engineers under 33 U.S.C. s 1344 if the contributions will meet the mitigation requirements of the United States Army Corps of Engineers. Payment may be made in the form of monetary contributions according to a fee schedule established by the Environmental Management Commission or in the form of donations of real property provided that the property is approved by the Department as a suitable site consistent with the basinwide wetlands restoration plan.

(c) Accounting of Payments.--The Department shall provide an itemized statement that accounts for each payment into the Fund. The statement shall include the expenses and activities financed by the payment.

Added by Laws 1996, 2 Ex.Sess., c. 18, s 27.4(a), eff. July 1, 1996.

§ 143-214.13. Wetlands Restoration Program: reporting requirement

The Department of Environment, Health, and Natural Resources shall report each year by November 1 to the Environmental Review Commission regarding its progress in implementing the Wetlands Restoration Program and its use of the funds in the Wetlands Restoration Fund. The report shall document statewide wetlands losses and gains and compensatory mitigation performed under G.S. 143-214.8 through G.S. 143-214.12. The report shall also provide an accounting of receipts and disbursements of the Wetlands Restoration Fund, an analysis of the per-acre cost of wetlands restoration, and a cost comparison on a per-acre basis between the State's Wetland Restoration Program and private mitigation banks. The Department shall also send a copy of its report to the Fiscal Research Division of the General Assembly.

Added by Laws 1996, 2 Ex.Sess., c. 18, s 27.4(a), eff. July 1, 1996.

SUBCHAPTER 2R - WETLANDS RESTORATION PROGRAM

SECTION .0500 - WETLANDS RESTORATION FUND

.0501 PURPOSE

(a) The purpose of the Wetlands Restoration Fund (Fund) is to provide a repository for monetary contributions or payments and donations or dedications of interests in real property. Fund assets will be used to promote the restoration, enhancement, preservation, or creation of wetlands and riparian areas. Fund assets will only be used for the purpose of contributing directly to the acquisition, perpetual maintenance, enhancement, restoration, or creation of wetlands and riparian areas as described in G.S. 143-214.8 through 143-214.13 in accordance with the wetlands restoration plans developed for each river basin.

(b) Payments into the Fund as determined in accordance with Rule .0502 of this Section shall be considered as compliance with the compensatory mitigation requirements of certifications issued by the Department under 33 U.S.C. § 1341; and permits or authorizations issued by the United States Army Corps of Engineers under 33 U.S.C. § 1344 if the contributions will meet the mitigation requirements of the U. S. Army Corps of Engineers.

(c) Donations or dedications of interest in real property may be accepted if consistent with the goals and objectives of the restoration plan for the river basin as determined by the Secretary or Designee.

*History Note: Authority G.S. 143-214.11; 143-214.12;
Temporary Adoption Eff. May 6, 1997.*

.0502 DEFINITIONS

(a) Compensatory mitigation means the restoration, creation, enhancement or preservation of wetlands, riparian areas and classified surface waters that is required as a condition of certifications issued by the Department under 33 U.S.C. § 1341 and permits or authorizations issued by the United States Army Corps of Engineers under 33 U.S.C. § 1341.

(b) Non-riparian wetlands means Class WL wetlands as defined in 15A NCAC 2B .0101(c)(8) whose major source of water is precipitation. Wetland types generally considered to be non-riparian include wet flats, pocosins and ephemeral wetlands.

(c) Riparian wetlands means Class WL wetlands as defined in 15A NCAC 2B .0101(c)(8) whose major source of water is ground water or surface water. Wetland types generally considered to be riparian include freshwater marshes, swamp forests, bottomland hardwood forests, headwater forests, bog forests, mountain bogs and seeps.

*History Note: Authority G.S. 143-214.11; 143-214.12;
Temporary Adoption Eff. May 6, 1997.*

.0503 SCHEDULE OF FEES

(a) This schedule of fees is based on the cost of restoring or creating wetlands or surface waters capable of performing the same or similar functions as the wetlands or surface waters that have been impaired by permitted development projects. The fees include directly related costs of restoration planning, land acquisition, long-term monitoring, maintenance and preservation of restored areas.

(b) The amount of payment into the Fund in lieu of compensatory mitigation requirements as described in Rule .0501(b) of this Section shall be determined in accordance with Subparagraphs (1) through (3) of this Paragraph. The fee will be based on the acres and types of compensatory mitigation specified in the approved U.S. Army Corps of Engineers permit under 33 U.S.C. § 1344 or the certification issued by this Department under 33 U.S.C. § 1341. Payments shall be calculated in 0.25 acre increments for wetlands and by the linear foot for streams.

(1) Classified surface waters other than wetlands as defined in 15A NCAC 2B .0202. The payment shall be one hundred twenty-five dollars (\$125.00) per linear foot of stream.

(2) Class WL wetlands as defined in 15A NCAC 2B .0101(c)(8). The payment shall be:

- (A) twelve thousand dollars (\$12,000) per acre for non-riparian wetlands.
- (B) twenty-four thousand dollars (\$24,000) per acre for riparian wetlands.

(3) Class SWL wetlands as defined in 15A NCAC 2B .0101(d)(4). The payment shall be one hundred twenty thousand dollars (\$120,000) per acre.

(c) Donations or dedications of interest in real property may be accepted in lieu of compensatory mitigation requirements as described in Rule .0501(b) of this Section provided that the property has been identified as an approved site in the restoration plan developed for each river basin. Other properties may be considered by the

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Secretary or his designee on a case-by-case basis. The decision on whether to accept other properties shall include a determination that restoration or preservation of the property is consistent with the goals and objectives of the restoration plan for the river basin. The amount of credit for donations of property shall consider the costs of restoration planning, long-term monitoring, and maintenance of the donated property.

(d) This fee schedule will be subject to update and revision upon determination that assessed fees vary from the actual costs of restoration activities described in Rule .0501(a) of this Section.

*History Note: Authority G.S. 143-214.11; 143-214.12;
Temporary Adoption Eff. May 6, 1997.*

.0504 PAYMENT

(a) Payment of fees shall be made by check or electronic fund transfer to the North Carolina Wetland Restoration Fund.

(b) Donations or dedications of interest in real property shall be deeded to the State of North Carolina or to other public or private nonprofit conservation organizations as approved by the Department.

*History Note: Authority G.S. 143-214.11; 143-214.12;
Temporary Adoption Eff. May 6, 1997.*

**Announcement of Public Hearing
on the Proposed Nutrient Sensitive Waters Management Strategy
for the Neuse River**

North Carolina Environmental Management Commission

Background

Environmental conditions in the Neuse River are driven by complex interactions between rainfall, flows, temperatures, biological factors and chemistry. Each year brings its own

variations. However, the long history of problems with nutrient pollution and algal blooms provides solid evidence that immediate control measures are necessary.



In response to these concerns, the Environmental Management Commission (EMC) adopted a draft conceptual Neuse River Nutrient Sensitive Waters (NSW) Management Strategy in February 1996. This proposed draft strategy included a proposed management strategy for point and nonpoint sources of nutrients. In accordance with North Carolina general statutes, four public hearings were held in November 1996. Nine hundred and sixteen people attended the public hearings, with 201 of them making comments at the hearings. In addition to the speakers' comments, DWQ received over 300 written comments on the proposed strategy.

The Neuse River NSW Management Strategy have been revised on the basis of the Hearing Officers' review and analysis of public input from concerned citizens, interested groups and other organizations. The revised strategy was approved by the EMC in June 1997. In accordance with the Administrative Procedure Act, the revised rules will have to be re-noticed and public comment received for a period of 60 days following publication of the final notice due to substantial differences from the originally proposed rules. The public comment period will extend from September 15, 1997 to November 14, 1997. The public hearings will be held in Raleigh and New Bern on October 7. Details on the hearing locations are included at the end of this announcement.

The Revised Rules

The goal of the Neuse River NSW Management Strategy is to reduce by 30 percent the 1991-1995 average annual load of nitrogen from point and nonpoint sources to the Neuse River. To achieve this goal, a number of voluntary and mandatory strategies have been proposed. Below is a list of the revised rules.

Protection and Maintenance of Existing Riparian Buffers

The rule to protect and maintain existing riparian areas was approved and became effective as a temporary rule by the EMC on July 22, 1997. This rule requires that existing riparian (streamside) areas be protected and maintained on both sides of intermittent and perennial

surface waters. This rule does not establish new buffers. A total of 50 feet of riparian area is required on each side of certain waterbodies in the basin. This 50 foot riparian area consists of 30 feet of virtually undisturbed forest and 20 feet of grassed/vegetated area or trees that could be harvested. In the basin's larger urban areas, protection of existing riparian areas would be a component of the urban stormwater programs discussed below.

Wastewater Discharges

The purpose of the wastewater discharge requirements for the Neuse River Basin is to establish an equitable strategy that will mandate a cumulative 30 percent reduction in point source total nitrogen loading to the Neuse River Estuary. The strategy provides for several management options from which dischargers may select to comply with the proposed rules. This allows for flexibility in the management approach while maintaining a firm commitment to the 30 percent total nitrogen reduction goal. Dischargers in the Neuse River basin have two options: to meet the new requirements individually, or to join together as an association to meet the 30 percent N reduction collectively. Within each of the two options, dischargers have the flexibility to meet 30 percent reduction goal by optimizing their facility's operation, implementing plant improvements, reducing flows through water conservation and repairing leaky sewers, and paying nitrogen offset fees.

Urban Stormwater Requirements

The basinwide stormwater program requires that 10 cities and five counties (Cary, Durham, Garner, Goldsboro, Havelock, Kinston, New Bern, Raleigh, Smithfield, Wilson, Durham County, Johnston County, Orange County, Wake County and Wayne County) develop a stormwater management plan to address nutrients. The stormwater management plan requires these local governments to review and approve stormwater management plans for new development, implement a public education program, identify and remove illegal discharges to the storm sewer system, identify suitable locations for installing stormwater management practices in areas of existing development, and provide annual nitrogen load reporting. The affected local governments would administer the review and approval of development plans. New developments will be required to maintain a nitrogen loading of 70 percent or less of the 1995 loading and provide no net increase in the pre-development peak flow from the 1-year, 24-hour storm.

Agricultural Best Management Practices for Nitrogen Reduction

Under the revised proposal, persons engaging in agricultural operations in the Neuse River Basin have two options for meeting the nitrogen net loading reduction. The options are to either participate in a county nitrogen reduction plan or implement standard Best Management Practices. The two options are as follows:

Option 1 - County Nitrogen Reduction Plan

Farmers may choose to participate in the development and implementation of a countywide plan to reduce nitrogen loading. County Advisory Committees would develop, review and approve site-specific plans for nitrogen, based on the overall County Nitrogen Reduction goal. These committees will be comprised of representatives from the Natural Resources Conservation Service (NRCS), N.C. Cooperative Extension Service (CES), Division of Soil and

Water Conservation (DSWC), N.C. Department of Agriculture (NCDA), local Soil and Water Conservation Districts (SWCD), and a county farmer. The committees would be formed by the Directors of the DSWC and the DWQ.

Option 2 - Standard Best Management Practices (BMPs)

If option 1 is not selected, then the agricultural operation must implement standard BMPs. The standard BMPs include riparian vegetative areas, controlled drainage and nutrient management. These would be required to be established within 4 years of the effective date of the rule.

In addition to the County Advisory Committees, a Basin Oversight Committee will be formed by DSWC and DWQ. This group will have the responsibility of reviewing each county's nitrogen reduction plan. The Basin Oversight Committee would include one representative each from NRCS, DSWC, NCDA, CES, DWQ, an environmental interest group, the scientific community, and a farmer. Additional responsibilities of the Basin Oversight Committee would be to:

- Develop a tracking and accounting method for evaluating nitrogen loading from agricultural sources.
- Review, approve and summarize County Nitrogen Reduction Plans and report findings to the EMC.
- Allocate to counties their individual portion of the nitrogen loading reduction from agricultural operations. Each county may not have to reduce their individual nitrogen loading by 30 percent. However, the nitrogen loading reduction should collectively meet the total nitrogen reduction goal.

Nutrient Management Requirements

What this proposed rule would mean to applicators who apply nutrients to 50 or more acres per calendar year of cropland, golf course, recreational lands, residential, commercial, industrial, right-of-way or other turfgrass areas is:

- Persons must successfully complete nutrient management training and certification delivered by the CES or DWQ within 5 years of the effective date of the rule, -OR-
- Persons will be required to develop and implement nutrient management plans for the lands where nutrients are applied.
- Nutrient management plans must be approved by a technical specialist designated by the Soil and Water Conservation Commission (SWCC).

Additional Material

Staff of the DWQ can provide additional material on the proposals and hearings. DWQ has prepared several documents to help you understand what the EMC is proposing for the Neuse River NSW Management Strategy. The documents are of varying length and detail, and may be focused on specific aspects of the proposed rules. The following documents are available:

- 1) Report of Proceedings on the Proposed Neuse River Basin Nutrient Sensitive Waters (NSW) Management Strategy (88 pages)

- 2) Draft Fiscal Analysis - a comprehensive discussion of the estimated fiscal impacts of the proposed rules to local governments, other affected parties and the implementing agencies. (Approx. 170 pages)

You may request these documents by calling Marsha Byrd at (919)733-5083, ext 558. If possible, please refer to the document number listed above (for example, #1 or #2) when making your request.

Questions

Questions concerning the point source discharge requirements can be directed to Coleen Sullins at (919)733-5083, ext. 550. You may direct other questions to Annette Lucas at (919)733-5083, ext. 587.

Submitting Comments

We will accept your verbal and written comments during the hearings. We will also accept your written comments before or after the hearing, but no later than November 14, 1997. You may submit your comments to:

Lin Xu
DEHNR/Division of Water Quality
Planning Branch
P.O. Box 29535
Raleigh, NC 27626-0535

All persons interested and potentially affected by the proposals are strongly encouraged to read this entire announcement and supporting information and make comments on the revised rules. The proposed effective date of the final rules is August 1, 1998.

Public Hearing Dates And Locations

Date: October 7, 1997 (Tuesday), 7:00 P.M.
Location: Raleigh, State Highway Building Auditorium
Address: 11 S. Wilmington Street, Raleigh, North Carolina
Directions: Across from the east side of the Capitol in downtown Raleigh

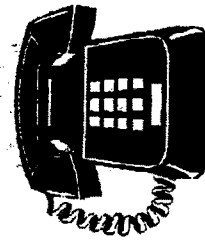
Date: October 7, 1997 (Tuesday), 7:00 P.M.
Location: New Bern, Craven County Courthouse
Address: 302 Broad St., New Bern, North Carolina
Directions: From Highway 70 East Bypass, take the East Front St., cross the Trent River toward downtown New Bern, make a left at Broad Street, then a right at Craven St. The Courthouse will be on your left.

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- WARNING - POTENTIAL WATER PROBLEMS

The North Carolina State Health Director is warning swimmers, boaters, fishermen, water skiers and others to **avoid fish or shellfish that are dead, dying, contain sores, or appear ill, as well as the waters that contain such fish.** This warning should be followed during any fish kill event and for at least 24 hours after a fish kill has ended.

Please report fish kills to the *Division of Water Quality* at



919-733-5083 during business hours, or
1-800-858-0368 after hours, on weekends
or holidays.

Please report health symptoms from 8:00 a.m.
to 5:00 p.m. weekdays at **1-800-662-7030**.

U.S. House of Representatives Committee of Resources
 Subcommittee on Fisheries Conservation, Wildlife and Oceans
 Testimony of Christophe A. G. Tulou
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Ladies and gentlemen, members of the Subcommittee on Fisheries, Conservation, Wildlife and Oceans, I am Christophe Tulou, Secretary of the Delaware Department of Natural Resources and Environmental Control for the State of Delaware. I appreciate the opportunity to testify today and share Delaware's experience with the organism which has dominated headlines in our region the past several months.

First of all I would like to applaud the members of this Subcommittee and other members of Congress, including our Delaware delegation, for their support and offers of assistance in combating the threats of Pfiesteria. Likewise, the ongoing support of federal agencies such as the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, the Environmental Protection Agency and the Centers for Disease Control has been invaluable to States such as mine which do not have the resources available to conduct all of the research needed to manage threats from Pfiesteria.

Today I will provide a summary of Pfiesteria issues in Delaware including the State's response to concerns about the organism, how the State is managing the threat from Pfiesteria and what may be needed in the future to control problems associated with Pfiesteria.

Part I -- What Delaware is doing about Pfiesteria

In response to increasing concerns about the potential impact of Pfiesteria in Delaware waters, the State formed a Pfiesteria Response Team in June 1997, comprised of the Division of Fish and Wildlife, Division of Water Resources, DNREC Office of Information and Education, and the Division of Public Health.

As a result of concerns about the problems on Maryland's Eastern Shore, and because Pfiesteria was linked to a major fish kill in Delaware's Indian River in 1987, Delaware worked with Dr. JoAnn Burkholder to collect and analyze samples from Indian River, Indian River Bay and Rehoboth Bay in early August of this year. Water samples confirmed the presence of Pfiesteria in three of five samples. The Pfiesteria taken from Indian River did not produce toxins in a laboratory setting suggesting it was not in a toxic stage this summer in Delaware waters.

Information about the findings was shared with tourism officials as well as with coastal Chambers of Commerce concurrent with their release to the media in mid-August.

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Because lesions on fish are the best indicator of Pfiesteria activity, DNREC has stepped up surveillance of fish populations in the Inland Bays. To date, several thousand fish have been examined and none have exhibited characteristics which suggest that Pfiesteria is active in Delaware waters. Fish have also been examined in the Delaware portion of the Nanticoke River, a tributary of the Chesapeake Bay (near the MD-DE line), and no fish showed any symptoms associated with Pfiesteria.

In addition, standard DNREC fish kill investigative procedures have been modified to include precautions for field investigators to protect themselves when investigating fish kills suspected to have been caused by Pfiesteria. Additional instructions were provided on what to look for and how to preserve appropriate fish and water samples.

The Division of Fish and Wildlife has also circulated logs to anglers who regularly fish along Indian River to keep tabs of the percentage of fish which may have lesions. DNREC staff have also been coordinating with counterparts in Maryland and with the U.S. Fish and Wildlife Service and National Marine Fisheries Service to establish training to better identify symptoms associated with Pfiesteria in fish.

The U.S. Fish and Wildlife Service has agreed to provide assistance in gross necropsy testing and preparation of tissue samples to be shipped to specialized labs. They have also offered access to the Service's Northeast Fisheries Center.

Staff with the Division of Public Health have distributed information to the medical community in Delaware on potential public health effects associated with exposure to Pfiesteria. To date, the State has received no reports of adverse health effects attributable to Pfiesteria.

Part Two -- What are the threats to Delaware's waters and the State's response?

The potential economic impact to Delaware from a Pfiesteria outbreak (fish with lesions, fish kills, or public health effects) could be enormous. Tourists to Delaware beaches pumped \$250 million into the local economy in 1990, and more than \$84 million was spent by recreational boaters. Despite the relatively light regional coverage associated with our discovery of Pfiesteria-like organisms in our Inland Bays this summer, anecdotal reports suggest that there was some minor impact on the coastal tourism industry and on commercial and recreational fishing.

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Delaware has developed a response protocol in the event that the State experiences fish with lesions, fish kills or reported public health effects. In the event that 20 percent of the fish in an area exhibit lesions, the State will issue an advisory urging people not to recreate in that area. Should a fish kill occur in an area where fish also exhibit lesions, the State will close the waterway to the public.

Part Three -- How do we manage the threat of Pfiesteria?

Dr. JoAnn Burkholder and Dr. Howard Glasgow at North Carolina State University have shown -- in the laboratory and the field -- that Pfiesteria can be highly stimulated by nutrient enrichment. This finding strongly suggests that our longer-term answer to the Pfiesteria problem will involve better control of nutrients flowing into Delaware waterways.

I would note, however, that we already have many other reasons to take aggressive action to control nutrient loading in our estuarine waters. In Delaware's Inland Bays, for example, not only are Pfiesteria-like organisms present, but so is a gross overabundance of sea lettuce -- a macroalga -- that has proliferated especially during the past two summers. In fact, the sea lettuce piles up feet deep on some Inland Bay shores. As it dies and decays, this product of nutrient enrichment robs the water of oxygen, creating vast dead zones and -- not surprisingly -- a great stench. The adverse implications of nutrient enrichment are numerous and profound.

For these reasons, the State of Delaware is committed to meet its water quality obligations through our Whole Basin Management program which focuses a concerted, multi-disciplinary effort to identify and rectify those activities that overly compromise water quality and our ability to use our waterbodies for their intended purposes, including fishing and swimming.

Nutrient loadings can come from a variety of sources -- wastewater discharges from communities or industry, septic systems, runoff from agricultural operations, lawns, other development and atmospheric deposition. Delaware is currently exploring the possibility of removing several point source discharges from the Inland Bays, but has also made vast strides with the construction of several new wastewater collection systems which has resulted in thousands of septic systems being taken out of service in the Inland Bays watershed.

States around the country have been grappling with controlling nonpoint source pollution. Delaware, with the help of a number of Federal and State partners, has been particularly aggressive in trying to control this source of pollution.

For example, a great deal of work has been done to improve nutrient management Statewide, including strong efforts in the Inland Bays and Chesapeake Bay watersheds.

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Among the nutrient management programs we already have in place are the following:

- **Best Management Practices (BMPs):** State and Federal cost share funds and State Revolving Fund (SRF) loans are being used to implement Best Management Practices that protect water quality. For the period FY94 through FY98 Delaware provided \$2,860,000 in cost share funds to construct urban and agricultural Best Management Practices such as stormwater ponds to control runoff, vegetative buffer strips along streams, manure storage structures, dead animal composters, and soil erosion control measures;
- **State Revolving Loan Fund:** Since the Fall of 1993, the Conservation Districts, using EPA and DNREC funds, have worked to make almost \$1,600,000 in low interest (3%) loan loans available to over 190 poultry and dairy producers to construct manure storage structures, dead animal composters, manure handling and application equipment;
- **Environmental Quality Incentives Program (EQIP):** Delaware was awarded \$673,000 in Federal FY97. The program targets four priority areas including the Nanticoke River watershed, the Inland Bays watershed and Statewide nutrient management;
- **New Delaware Guidelines for animal producers:** A two-year effort to update and re-format Delaware's voluntary environmental guidelines for animal producers is complete and due to be distributed to every animal producer in the Delaware. These "Guidelines" summarize the latest information and techniques for managing on-farm nutrients;
- **Nonpoint Source Pollution Program:** Federal funding through this program has: supported four conservation district planners who work with agricultural producers in Kent and Sussex Counties to reduce runoff; funded the development of new septic system technology to reduce nutrient loadings to ground water; and funded the development of new stormwater management techniques that will make better use of natural vegetation to reduce runoff from new development;
- **Cover Crop Initiative:** Staff from the DNREC Division of Soil and Water Conservation have met with Maryland officials and designed a cover crop project that parallels the Maryland program. These cover crops will reduce nutrient runoff into waterways. Delaware's project will use up to \$150,000 of unobligated FY98 Conservation Cost Share funds that has been made available to Delaware's conservation districts.

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Part Four -- What research needs to be conducted and what other resources might be needed in order to assist States in meeting the challenges posed by Pfiesteria?

DNREC is not a research institution, and we have no such designs. We are, however, very interested in participating in an effective partnership to resolve unanswered questions about Pfiesteria. I suspect the best way to get those answers is through a large, coordinated effort involving a variety of experts from affected States, Federal agencies and the private sector -- notably including the agricultural industry. Indeed, several Federal agencies have already extended offers of assistance, including the Department of the Interior's U.S. Fish and Wildlife Service, the National Marine Fisheries Service in the Department of Commerce, the U.S. Environmental Protection Agency and the Centers for Disease Control.

Our biggest challenge is to identify as certainly as we can those factors that promote the proliferation and toxic activity of these organisms. Researchers have already identified the stimulating effects of phosphorous and nitrogen on Pfiesteria. They also suggest that the organism's nutrition is complex, and that other materials could also stimulate its growth. We need more research to determine whether other stimulatory factors exist.

Unknown substances either excreted or secreted by fish have been shown by these researchers to stimulate toxic forms of Pfiesteria. What environmental conditions might influence this biological transformation? Further research will provide even better foundation for the actions necessary to alleviate the threat of outbreaks.

Also troubling are the potential health effects associated with exposure to Pfiesteria. We applaud efforts -- sponsored by members of this Subcommittee and others -- to provide funding to the Centers for Disease Control to support coordinated regional research and response to the public health issues associated with the organism. Again, producing the answers necessary to protect public health and the environment requires this type of coordination and cooperation.

I appreciate the opportunity to appear before you today and would be glad to entertain any questions.

TESTIMONY
TO
U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON RESOURCES
FISHERIES CONSERVATION, WILDLIFE AND OCEANS
SUBCOMMITTEE
OCTOBER 9, 1997
PRESENTED BY
RICHARD J. DOVE
NEUSE RIVERKEEPER
Sponsored by
THE NEUSE RIVER FOUNDATION, INC.
OF
NEW BERN, NORTH CAROLINA

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OPENING STATEMENT

The problem is pollution. Mountains with dead trees, acid rain and choking air, mutated frogs and alligators, dying coral reefs, dwindling numbers of manatee and millions of dead fish--these things, like pfiesteria, are symptoms of pollution. We have much more to lose than our wildlife--it is already happening.

INTRODUCTION

At the outset I want to express my sincere thanks to Congressman Saxton and the House Committee on Resources for scheduling this hearing and inviting me to relate my observations concerning pollution problems in the Neuse River.

I am Rick Dove and I have lived on the shores of the Neuse River for over 20 years. In 1993, after retiring from a career in the United States Marine Corps, I pursued a childhood dream and became a commercial fisherman. With three boats and a seafood outlet store in Havelock, North Carolina, my son Todd and I worked over 600 crab pots and more than 2,000 feet of gill nets. This activity continued until 1990, when many of the fish and crabs started showing the telltale sores of what would later be identified as pfiesteria lesions. I had first seen these sores on fish taken from the Neuse in the mid-1980s. However, during that period, they were few and far between. Between 1987 and 1990, I watched as more and more fish and crabs showed signs of infection. So great was my concern that I stopped eating the local seafood; I abandoned my fishing enterprise; and I grudgingly returned to wearing a suit and tie in a civilian law practice.

In early 1993, the Neuse River Foundation advertised for the position of Riverkeeper for the Neuse River. I was hired for this position and set to work on April 1, 1993. As the Neuse Riverkeeper, I am a full time paid citizen representative whose duty it is to restore, protect and enhance the waters of the Neuse and all its tributaries. This watershed covers over 6,000 square miles. I am assisted in the performance of my duties by more than 300 active volunteers who serve as creekkeepers, streamkeepers, pilots and others. A detailed explanation of the Neuse Riverkeeper Program and the Neuse River Foundation is set forth in Appendix 1.

PROBLEMS ON THE NEUSE:

The Neuse River is over 2,000,000 years old and is one of the most important natural resources in the state. A detailed history of the Neuse is set forth in Appendix 2. Once healthy and productive, today the Neuse River has become the poster child for North Carolina's degraded natural resources.

In 1991, according to rough estimates of state officials, over one billion fish, mostly menhaden, perished during a pfiesteria fish kill in September and October. This is the largest fish kill ever recorded in North Carolina. There were so many dead fish that some had to be bulldozed into the ground. Others were simply left to rot on the shore and river bottom. The smell produced by this kill will never be forgotten. Another large fish kill occurred in August through November 1995. In that kill, fish were dying over a period of 100 days. No state officials documented the number of dead fish from this kill, but scientifically conducted estimates were compiled by volunteers of the Neuse River Foundation. They recorded over 10,000,000 dead fish in 10 of those 100 fish killing days.

The fish kills of 1991 and 1995 were clearly the result of pfiesteria attacks. During these kills, oxygen levels were normal. Moreover, the lesions typically associated with pfiesteria kills were present. In the 1995 kill, water samples verified the presence of pfiesteria toxins at highly lethal levels. I have also documented other smaller pfiesteria fish kills in every year I have served as the Neuse Riverkeeper. So far this year, during a six day period in June and July, I have documented the loss of over 390,000 menhaden resulting from pfiesteria attacks. Other types of fish in much smaller numbers have also been observed with pfiesteria-like lesions from March, 1997 through the present.

In the past, state officials have failed to properly survey and record fish kills on the Neuse and other rivers in North Carolina. The fish kills of 1991 and 1995 were poorly surveyed by the state. Moreover, in those kills where the evidence was clear and convincing that fish mortality was caused by pfiesteria, the state either ignored the kill or attributed the loss to low oxygen levels in the water. In a study published by the National Oceanic and Atmospheric Administration in September 1991, entitled, *Fish Kills in Coastal Waters 1980-1989*, it was reported that of all the states in the southern region, North Carolina fish kill reports were the most incomplete.

To be certain, there are many pollution problems on the Neuse River. Heavy metal sites, sedimentation, the excess discharge of toxins and the illegal discharge of raw human and animal waste are but a few examples. However, no problem compares with that of the gross over-nitrification of the Neuse. As demonstrated in Appendix 3, since the 1950s, nitrogen (NO_2 and NO_3) concentration levels being delivered from upstream sources to the Neuse estuary have doubled. Comparing the period 1985-1988 with 1991-1995, ammonia nitrogen (NH_3 and NH_4) concentrations measured at different places in the Neuse have more than doubled. This extreme increase in nitrogen, coupled with excessive phosphorus loading which has occurred over time, combine into a deadly cocktail which causes algal blooms harmful to fish and people. These blooms are now commonplace on the Neuse and many of its tributaries. Since 1990, major waterways and small creeks have become choked with this fish killing vegetation and toxic forms of blue green algae have appeared with regularity. The proliferation and deadly effects of pfiesteria have also been attributed to the high nutrient levels in the Neuse.

CONDITIONS FOR PFIESTERIA ATTACKS

After closely observing pfiesteria at work in the natural environment for more than five years, I have noted some interesting details which may be relevant to understanding optimal conditions under which it might proliferate and attack.

One critical ingredient necessary for pfiesteria attacks is the presence of large numbers of fish. This usually occurs in the Neuse estuary in the months of August through November when menhaden are present in extremely large numbers, just before they begin their fall migration to the ocean.

Clearly, pfiesteria seems to thrive in nutrient enriched brackish waters, such as the Neuse estuary, where the salt content is about 12 to 14 parts per thousand. Pfiesteria seems to prefer the quiet, more settled areas of these waters. When the main body of the Neuse is being churned by the winds, pfiesteria is usually found at work only in areas sheltered from the wind. As the winds calm, I have observed pfiesteria spreading from these areas across the entire expanse of the Neuse estuary near New Bern. This can happen in a matter of hours. The spread of pfiesteria attacks can be followed by watching fish struggle as they are hit by pfiesteria toxin. At first, large schools of menhaden begin to act erratically by thrashing about the surface, sometimes spinning wildly out of control, sometimes jumping out of the water as if they were trying to escape. On limited occasions I have seen menhaden and other fish escape the water by beaching themselves. Once affected by pfiesteria toxin, fish, especially menhaden, can be observed swimming in large schools in very shallow water. They swim in a circular motion and they are narcotized to the point where they are completely unaffected by other disturbing activity in the water such as the throwing of a rock or stirring with a stick. After a while, fish can be observed swimming with huge holes in their bodies. Then, one by one, they turn on their side, float to the surface and die. At first the birds feast on the carnage. When more fish die than the birds can eat, the river turns into a graveyard.

THE STATE'S FAILED RESPONSE

North Carolina is the 10th most populated state in the United States. The Institute for Southern Studies, Durham, North Carolina in its *Green Index Report* (1991-1992) ranked the State "in the bottom ten" of the 50 states for the amount of money, per capita, it spent to protect its environment. During that time it was also rated by the EPA as one of the top 10 states for putting toxic pollutants into the environment.

The state has also failed to follow the legally binding provisions of the Federal Clean Water Act (CWA) which require the establishment of total maximum daily load limits for those pollutants which degrade surface waters to the point where they fail to meet their designated uses. While the Environmental Protection Agency (EPA) has

lauded North Carolina for its basin wide water quality management program, so far this program has failed to make any meaningful contribution to improved water quality in the Neuse River. The Neuse River Foundation is currently suing the EPA for its failure to require North Carolina to adhere to the provisions of the Act.

Recently, there has been some positive movement in the state's efforts to improve water quality. In 1996, the General Assembly created the Clean Water Management Trust Fund, which guarantees a continuing source of revenue for clean water projects. During its first year the fund generated \$50 million to help clean up *all* the waters in North Carolina. In its 1997 session, the legislature approved the Clean Water Responsibility Act, putting a two-year moratorium on hog farms, reducing nutrient limits on wastewater discharges and improving land use management. These actions are a step in the right direction, but they represent an inch on our mile long journey. For example, the cost of restoring the Neuse River alone has been estimated at more than a billion dollars; the two year moratorium on new hog facilities is limited to larger hog operations; nothing has been done to eliminate hog lagoons; nothing in the law addresses the pollution contribution of turkey and chicken production facilities; and, the 5.5 m/l limit placed on nitrogen discharges at wastewater treatment plants will actually result in more nitrogen being discharged into the river as these plants continue to increase the volume of their discharges toward their permitted capacity.

SOLUTIONS

Restoring natural resources after years of neglect will be a painful and expensive endeavor for which federal intervention and assistance is clearly warranted. One clear cut solution for the pfiesteria problem and all other symptoms of pollution, is for the EPA to require states to strictly follow the provisions of the CWA. Section 303d of this Act already mandates pollution reduction where surface waters fail to support their designated uses. Federal District Courts have already rendered favorable environmental rulings in several states including Georgia and California. The EPA should mandate that states fully implement the Total Maximum Daily Load provisions of the CWA during a period not to exceed five years. Further, the EPA should require that all waters which do not support their established uses be fully restored in ten years. Considering the staggering cost of such an effort, some funding assistance will need to be provided by the federal government.

The CWA should also be strengthened and broadened to further address non-point sources of pollution. Unfortunately, the CWA does not apply to some agricultural problems, including intensive livestock operations (ILO). In North Carolina these operations are producing more feces and urine on a daily basis than is produced by all the people in the states of New York and California combined. Waste from these ILOs is stored in barns as dry waste or in lagoons (open cesspools) as liquid slurry. This waste is

eventually applied to farm fields which are heavily ditched to carry runoff to adjoining wetlands, streams, creeks and rivers. Moreover, according to the United States Department of Agriculture, more than 80% of all the nitrogen produced by these animals is discharged to the environment as ammonia gas. According to credible scientific studies, this ammonia travels in the air from 50 to 100 miles. Thereafter, 100% of this form of nitrogen is indiscriminately redeposited onto school yards, church yards, backyards, forests and surface waters, to identify but a few. In North Carolina, hogs alone produce approximately 200 million pounds of nitrogen per year. Most ILOs in North Carolina are critically located in the environmentally sensitive area east of Interstate-95. This small area is the watershed for the Neuse and other coastal rivers. The CWA should be amended to include ILOs. All nitrogen discharges to the environment from ILOs can and should be eliminated. Charts illustrating animal loadings and nitrogen increases from hogs in the Neuse River watershed are set forth in Appendix 4.

What about pfiesteria? To be certain it is a very dangerous organism. More than a billion dead fish can attest to the truth of that statement. And so too can I and other people who have witnessed its devastation or been sickened by exposure to it and other pathogens present in the Neuse. So serious are the human health consequences related to pollution problems in the Neuse that in March, 1997 more than 130 physicians from New Bern, North Carolina joined in a letter to Vice-President Gore seeking federal intervention.

When pollution produces dramatic symptoms like pfiesteria, there are extensive negative economic and health impacts. Tourism, fisheries and businesses associated with the affected waters suffer. For our health, both economic and physical, we must move quickly to better understand pfiesteria and how pollution promotes its virulence. To do so, we need money for pfiesteria research, but it must be spent wisely. It is important that any funds appropriated for such research be managed, applied and monitored by those scientists most familiar with the organism and its relation to water pollution, such as Doctor JoAnn Burkholder. But we must understand that researching pfiesteria will never solve the basic problem, only give us a better understanding of the definite relationship between pfiesteria and pollution. The ultimate solution is pollution abatement.

**THE NEUSE RIVERKEEPER PROGRAM
SPONSORED BY:
THE NEUSE RIVER FOUNDATION, INC.**

The Neuse Riverkeeper Program was established on April 1, 1993. Its sponsor, the Neuse River Foundation, Inc., a non-profit organization incorporated under the laws of the State of North Carolina, came into existence in October, 1980 when a group of citizens banded together to preserve and improve the quality of the waters of the Neuse River. The mission of the Neuse River Foundation and its 2,300 members is to be a viable agent for better water quality of the Neuse River through education, investigation, advocacy and public involvement. The Neuse River Foundation is the sole sponsor of the Neuse Riverkeeper.

A full time, paid citizen representative, the Neuse Riverkeeper's is to advocate for improved water quality of the Neuse River. The Neuse Riverkeeper is one of more than 20 Keepers licensed to serve throughout the country by the National Alliance of River, Bay and Sound Keepers, a national environmental group with its headquarters in Garrison New York. There are currently two other Riverkeeper programs licensed in North Carolina.

The Neuse Riverkeeper patrols the Neuse River and its shoreline by boat, aircraft and truck in order to locate and eliminate pollution sources. He is assisted by a force of over 300 active Neuse River Foundation volunteers. These volunteers serve as creekkeepers, streamkeepers and pilots of the Neuse River Air Force.

Working closely with the Neuse River Foundation, the Neuse Riverkeeper monitors NPDES permits. He interacts with agents of the state and federal government, including all relevant agencies and representatives involved with water quality protection. He coordinates his efforts with scientists and other researchers working on watershed problems. A key function of the Neuse Riverkeeper is to educate the public concerning water quality problems. In this regard, over the past 4 years, the Neuse Riverkeeper has made presentations to over 10,000 adults and school children concerning the Neuse River.

A recap of the duties and functions of the Neuse Riverkeeper are as follows:

- (1) Patrols the Neuse River by boat, plane and vehicle
- (2) Coordinates the Neuse River Creek Keeper, Air Force and Lookout Programs
- (3) Locates, investigates and eliminates pollution sources
- (4) Works independently and with government agencies in water monitoring programs
- (5) Assists members of the scientific community on water quality matters including research
- (6) Supervises the Neuse River Hot Line Service
- (7) Monitors NPDES permit applications and renewals
- (8) Maintains an active education program for adults and children
- (9) Disseminates information
- (10) Initiates environmental litigation

THE NEUSE RIVER

The Neuse River begins in Durham, North Carolina with the confluence of the Eno and Flat Rivers. From there to the Coast the Neuse travels a total distance of approximately 250 miles. The 6,192 square miles of the Neuse watershed is fully contained within the boundaries of North Carolina. Once the Neuse passes adjacent to the State Capital of Raleigh, it begins a 150 mile nearly free flowing journey to New Bern. For most of this journey, the Neuse narrowly turns and twists like a watery snake through forests and farmlands, swamps and densely populated areas. However, at New Bern, where the Neuse's fresh water turns brackish, the Neuse becomes an extremely wide, shallow and slow moving body of water with characteristics more of a lake than a river. This is due to the influence of North Carolina's Outer Banks which essentially dam in the waters of the Albemarle-Pamlico Sound. As one of the three major rivers which flow into the Albemarle-Pamlico Sound, the Neuse becomes part of the second largest and most productive estuary in the United States. These final 50 sluggish miles of the Neuse are where upstream pollutants are delivered, settled and retained. It is also an area where the Neuse transfigures itself into one of the widest rivers in the country (6 miles at its mouth). In this 50 mile area, between 1992 and 1996, polluted waters resulted in the death of over 1 billion fish.

The Neuse River is home to a large variety of fish, both commercial and recreational, and other wildlife. Shark, tarpon, blue fish, menhaden, flounder, striped bass, gray and speckled trout, croakers, and crabs all live in close proximity to freshwater species like catfish, bass and brim.

The Neuse is estimated to be approximately 2 million years old. Archaeological evidence indicates the first humans settled around the Neuse as early as 14,000 years ago. The early native Americans included the Tuscaroras, Coree, and Neusiok and Secotan tribes. A struggle between early European settlers and the Tuscaroras reduced the European population from 30,000 to 5,000 after the decisive "Tuscarora War" in 1714. As new settlers populated North Carolina over the next two and one-half centuries, farming and forestry took hold. Today, no other river in the Albemarle-Pamlico region is as developed as the Neuse. Over 1.5 million people live in the watershed, from the sprawling suburbs of Raleigh to the golf-and-sail communities below New Bern.

In 1995, 1996 and 1997, American Rivers, a nationally renowned environmental group, rated the Neuse River as one of the 20 most threatened rivers in North America. The Neuse was the only river in North Carolina which has been listed. Unfortunately, the State of North Carolina has been unable to effectively protect the Neuse from pollution degradation. Although the State has declared two portions of the Neuse River "Nutrient Sensitive Waters"

(NSW)--Falls Lake in 1983 and the lower Neuse in 1988--it has been ineffective in limiting the discharge of phosphorus and nitrogen from point and non-point sources and in stemming the resulting eutrophication. Other identified concerns include high toxin levels, six known areas of extensive heavy metal contamination in the lower Neuse, recurring catastrophic fish kills from *pfisteria* attacks and abundant sedimentation.

Currently, over 400 point source discharge permits are active in the watershed, by far the largest number for any tributary river of the Albemarle-Pamlico Sound. Over 100 million gallons of partially treated wastewater are discharged into the Neuse each day. Since 1950, there has been a 650% increase in the amount of partially treated wastewater being discharged into the Neuse River.

Nonpoint runoff is another significant pollution problem in the Neuse River watershed. North Carolina has always been a large farming state. It is number one in the nation in production of turkeys, and second nationally in the production of chickens and hogs. While all these operations are permitted in North Carolina as zero discharge (non-discharge) systems, they account for more than one-third of the nitrogen that finds its way into the Neuse.

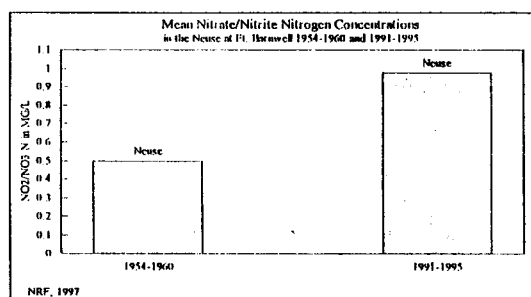
For the most part, animals in North Carolina are not raised on traditional farms. Instead they are produced inside of buildings in close confinement. This industrial style farming is heavily dependent on the use of antibiotics to maintain animal health. This represents a human health problem since antibiotics are becoming less effective in controlling the growth of bacteria. More alarming is the fact that most of these animals are being produced at industrial facilities located east of Interstate-95. This environmentally sensitive area is heavily inundated with blue line streams which carry farm runoff to the coastal waters of North Carolina.

The Neuse is used for recreational and commercial fishing, swimming, boating and transport. Fish harvested from the Neuse are shipped in interstate commerce to markets in the eastern United States. It is a river of immense beauty. Its health is a matter of great economic importance.

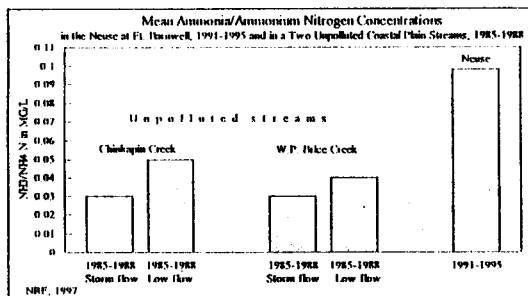
Nitrogen concentrations in the Neuse River during 1991-1995 as compared to the Neuse River in 1954-1960 and to other unpolluted streams

Because of the serious problems posed by algal growths in the Neuse estuary, the primary focus of one Neuse River Foundation research project was on the nitrogen-bearing compounds that have the major role in regulating and limiting such growths: nitrite/nitrate (NO_2/NO_3) and ammonia/ammonium (NH_3/NH_4). The full research report, authored by Carl M. Wagner, Ph.D., is available from the Neuse River Foundation, P.O. Box 15451, New Bern, NC 28561. It presents ten findings concerning concentrations of these compounds in the Neuse during 1991-1995 as compared to the Neuse in 1954-1960 and to other unpolluted streams. Two representative findings are:

- (1) At the Ft. Barnwell sampling site on the Neuse during 1954-1960, the mean NO_2/NO_3 nitrogen concentration was 51% of the mean NO_2/NO_3 nitrogen concentration at Ft. Barnwell during 1991-1995.



- (6) In two unpolluted Coastal Plain streams during 1985-1988, mean NH_3/NH_4 nitrogen concentrations ranged from 31% to 51% of the mean NH_3/NH_4 nitrogen concentration at Ft. Barnwell during 1991-1995.

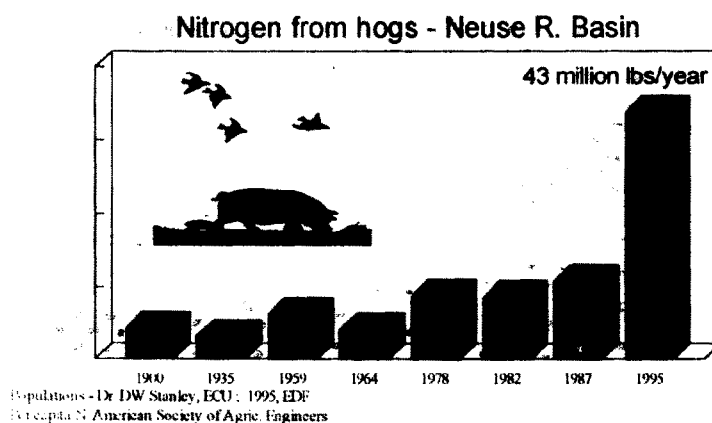


LIVESTOCK ANIMALS IN NORTH CAROLINA

AVERAGE NUMBER ON HAND

CHICKENS 1985	469,000,000
CHICKENS 1996	619,000,000
TURKEYS 1985	31,850,000
TURKEYS 1996	61,200,000
HOGS 1985	2,350,000
HOGS 1996	9,300,000

Data source: North Carolina Department of Agriculture 1997



WRITTEN STATEMENT OF
ROBERT PERCIASEPE
ASSISTANT ADMINISTRATOR, OFFICE OF WATER
U.S. ENVIRONMENTAL PROTECTION AGENCY
BEFORE THE
SUBCOMMITTEE ON FISHERIES CONSERVATION, WILDLIFE AND OCEANS
OF THE
COMMITTEE ON RESOURCES
U.S. HOUSE OF REPRESENTATIVES

October 9, 1997

Good morning Mr. Chairman and Members of the Subcommittee. I am Robert Perciasepe, Assistant Administrator of the Office of Water, U.S. Environmental Protection Agency (EPA). Thank you for this opportunity to present EPA's efforts to work with our federal, State and local partners regarding the potential risks to human health and safety, as well as the environmental impacts associated with outbreaks of the recently-identified dinoflagellate, *Pfiesteria piscicida*.

EPA first became concerned with *Pfiesteria* in the early 1990's when it was identified as a potential cause of massive fish kills in the Neuse River which is part of the Albemarle-Pamlico Sound Estuary Study, one of our Agency's National Estuary Programs (NEP). More recently, incidents in three States have increased the Agency's efforts. These incidents include fish kills and fish with lesions which may be attributable to *Pfiesteria* in Maryland and Virginia tributaries of the Chesapeake Bay, and -- based on monitoring rather than fish kills or lesions -- in the Indian River tributary to the Delaware Inland Bays NEP. Members of the "*Pfiesteria* complex" of organisms have been identified in coastal and estuarine waters from Delaware to the Gulf of Mexico.

Although the science on the ecology and human health effects associated with *Pfiesteria* is relatively new, the apparent public health and environmental impacts are immediate, and require immediate response. These impacts, combined with the state of the science concerning *Pfiesteria*, require a long-term research plan, in addition to strategies for preventing and responding to future outbreaks of *Pfiesteria* and other harmful algal blooms (HAB), such as red and brown tides. My statement will review briefly what we know about the toxic micro-organisms that cause these outbreaks, then discuss EPA's strategy for addressing these incidents, which includes -- supporting State response efforts; coordinating research with the National Oceanic and Atmospheric Administration (NOAA) and other federal agencies; and, enhancing prevention activities.

BACKGROUND

Marine biotoxins and harmful algae represent a significant and expanding threat to human health, marine mammals, and fisheries resources throughout the United States. Although understanding the human health and environmental effects of *Pfiesteria* is still in the research phase, public health officials and coastal and ocean resource managers have had to increasingly respond to the adverse and sometimes fatal impacts from similar micro-organisms in other parts of the country. In addition to the human health effects potentially associated with *Pfiesteria*, a variety of human illnesses are associated with other forms of toxic algal blooms and consumption of

toxin-contaminated fish or shellfish in the United States. Sea mammals, seabirds and other animals may also be victims of these biotoxins:

In addition to causing human and animal illnesses, the death and decay of algal blooms can lead to oxygen depletion in the water, resulting in widespread mortalities of fish, shellfish, and invertebrates. In addition, macroalgae can proliferate, resulting in displacement of native species and habitat alteration or oxygen depletion. There is strong evidence connecting these algal blooms with nutrient pollution — excessive nitrogen and phosphorus — in the water. The sources of these pollutants vary widely from one geographic location to another. However, in general, we see three significant sources: human waste, from septic systems or sewage treatment plants; agricultural runoff, from fertilizer or animal waste; and, air deposition from sources such as utilities and vehicles.

In response to the human health and environmental risks and impacts associated with such marine biotoxins and harmful algae, EPA, NOAA and other federal agencies have been working together with the States to better understand and, ultimately, manage or respond to harmful algal blooms in general, and most recently, to *Pfiesteria* in particular. EPA, USDA, and other agencies are especially interested in what steps can be taken to reduce nutrient pollution, in an effort to help prevent these outbreaks and their effects. For example, USDA has been conducting research on animal manure and nutrient management for many years to decrease nonpoint source pollution and nutrient enrichment of water.

EPA'S RESPONSE TO *PFIESTERIA*Support State Responses to Potential *Pfiesteria* Outbreaks

EPA, along with all of the other relevant federal agencies, is participating in a group led by NOAA's Chesapeake Bay Program Office to coordinate federal activities to help the mid-Atlantic States effectively respond to potential *Pfiesteria* outbreaks. This group, primarily composed of federal field office representatives, has identified a number of "near-term" or "immediate" activities that are critical to help the States, as well as other activities to help over the longer term. Some of the critical activities include: providing technical experts who can help conduct field sampling and analyze the results; serving as a clearinghouse for technical information to prevent duplication of effort and unnecessary expenditures of State resources; providing information for States to use in their public outreach and education efforts; helping States identify other "at-risk" sites that have a similar profile to those where outbreaks have occurred in an effort to be prepared or to prevent potential *Pfiesteria* outbreaks; helping States develop response plans for monitoring *Pfiesteria* outbreaks; and, conducting public outreach and education, and assessing sources of nitrogen and phosphorus (nutrient) pollution that could contribute to *Pfiesteria* outbreaks. Longer-term activities include workshops to build capacity within the States to continue these activities.

In particular, EPA, through its Chesapeake Bay Program Office, has provided funding to support Maryland's *Pfiesteria* response effort, including development of the Pocomoke Integrated Response Plan and characterization of nutrient pollution from

animal feeding operations in the watershed. The Chesapeake Bay program is also participating in the State of Maryland's *Pfiesteria* Coordination Team.

Coordinated Federal Research Strategy for *Pfiesteria*

EPA and many other federal agencies are conducting critical research that will help us understand the human health and environmental effects of *Pfiesteria* outbreaks, and the environmental factors (nitrogen and phosphorus and other factors) that may contribute to *Pfiesteria* outbreaks. Both of these areas of research are critical to responding appropriately to *Pfiesteria* outbreaks in a manner that will protect public health and safety and the environment, while avoiding negative economic impacts. EPA and NOAA are working together to lead a multi-agency group to ensure that there is a well-coordinated federal research strategy for *Pfiesteria*. This strategy will reflect the research that federal agencies are currently supporting as well as identify the needs and priorities for the future. The goal is to ensure that all our research efforts -- federal, State, and other -- are shared and are complementary, not redundant, and are addressing the key questions as quickly as possible. We expect to have a draft plan available by mid-October that we would then share for review by States, academia, and the public.

In particular, EPA's Office of Research and Development is currently working on several fronts of research that will help shed light on how to prevent and control future outbreaks of *Pfiesteria*. EPA, along with NOAA, the National Science Foundation (NSF) and the Office of Naval Research, are jointly funding, over a three-year period,

the Ecology and Oceanography of Harmful Algal Blooms (ECOHAB) research program. Recently-initiated studies in the first round of this competitive peer-reviewed program will contribute to a better understanding of harmful algal blooms, their effects on human health, and the role of nutrients on the growth of HABs. The results of these studies will be useful in assisting resource managers to predict where and when a toxic bloom may occur.

Furthermore, in support of the Interagency Committee on Environment and Natural Resources (CENR), EPA is also participating in the National Environmental Monitoring and Research Initiative. The National Environmental Monitoring and Research Initiative includes a pilot project in the Mid-Atlantic region which is designed to improve our understanding of the linkages among air, land, water, biota, and people; and, it will contribute to better environmental decision-making across the Mid-Atlantic region. This CENR pilot will increase our understanding of cause and effect, and allow us to better document current nutrient levels in Mid-Atlantic estuaries. These are only two of a myriad of examples of EPA research activities that we are coordinating with other federal agencies.

Reduce Nitrogen and Phosphorus Loadings From All Sources

This may be where EPA can make its greatest contribution to addressing the human health, environmental and economic impacts associated with *Pfiesteria* outbreaks and other harmful algal blooms. Although conclusive evidence has not yet been found to link nitrogen and phosphorus with toxic outbreaks of *Pfiesteria*, there is a

very strong association based on the outbreaks to date. In addition, there has been extensive research and strong evidence that excessive nitrogen and phosphorus levels lead to other harmful algal blooms (some of which are toxic and harmful to human health), such as red and brown tides, and can also lead to low levels of oxygen and fish kills. Therefore, further reducing the levels of nitrogen and phosphorus in our nation's waters is imperative to prevent the risks to human health and the environment caused by *Pfiesteria* outbreaks and other harmful algal blooms.

This is no simple task. The sources of nutrient pollution are many and varied. The sources of nitrogen and phosphorus also vary widely from one geographic location to another. Therefore, the solutions must also be varied; one approach will not suffice.

Specifically, I would like to highlight the following as some of the key areas where EPA believes greater reductions could be achieved in nutrient pollution in the nation's waters:

- There is no doubt that **nonpoint sources** of pollution are a serious remaining threat to the health of many of our waters.
 - ▶ EPA is supporting State efforts to **improve programs to control run-off** from a wide range of nonpoint sources. Many States are upgrading programs to address nine key program elements agreed to by EPA and the States.
 - ▶ We are working towards developing **water quality criteria for nitrogen and phosphorus**. The issuance of these scientifically-based criteria and their subsequent adoption by States into water quality standards is an important step towards controlling excess nitrogen and phosphorus in the nation's waters.

- 8 -

- ▶ We will also soon publish draft regulations to further define requirements for some **stormwater runoff** control from smaller urban areas. Currently, we regulate urban areas with populations of 100,000 or greater. The draft regulations will address smaller cities.

- ▶ **The Chesapeake Bay Program has committed to reducing nitrogen and phosphorus loadings to the Bay by 40% by the year 2000.** Each State is developing tributary strategies to meet that goal. Where tributary strategies are in place, the nutrient goals will be achieved. Where strategies are not yet in place, there are statutory deadlines to complete them and to set appropriate goals.
 - The Chesapeake Bay Program has recently determined, however, that implementation of some of the tributary strategies must be sped up to achieve the nutrient reduction goals. Of greater concern is the realization that the goals for reducing nitrogen and phosphorus from controllable sources may not be enough to assure the Bay's restoration due to new information indicating that nitrogen and phosphorus already in the soils and ground water will continue to pollute the Bay.
 - Through the Bay Program's research, we now realize that agricultural nutrient management plans for manure application has resulted in over-application of phosphorus. We will work with USDA and States to help farmers develop **nutrient management plans which consider phosphorus limits** for the first time.

- ▶ EPA and NOAA are approving **State Coastal Nonpoint Programs** under Section 6217 of the Coastal Zone Act Reauthorization Amendments (CZARA), and we are working with the States to ensure implementation of the programs.

- ▶ EPA is also increasing controls on **air deposition** of nitrogen. For example, our recently released revised NAAQS criteria for ozone and particulate matter are one step in reducing the air deposition contribution to nutrient pollution in the nation's waters. We are in the process of identifying and evaluating other such steps.

- We support the use of **low cost process changes for control of nitrogen and phosphorus at municipal wastewater plants.**
- EPA has been at the forefront of supporting the development and implementation of site-specific **watershed management plans** addressing excess nutrient loadings. This includes not only the current 28 National Estuary Programs, the Chesapeake Bay Program, and Gulf of Mexico hypoxia activities, but our assistance to States and local areas in using the watershed approach to address water quality problems. The watershed approach can help tailor the implementation of existing programs and the need for new actions to the problems and sources in that watershed.
- EPA will work with USDA and DOI to **support habitat restoration, and preservation and establishment of buffers**, to help reduce nitrogen and phosphorus loadings from nonpoint sources to susceptible waters.
- We support agricultural (including agricultural feeding operations not subject to NPDES permits) and other industries' efforts to **voluntarily implement best management practices** for reducing nonpoint source runoff of nitrogen and phosphorus.

- We are in the process of developing a comprehensive Agency-wide strategy of short and long term actions to **improve controls on animal feeding operations** throughout the nation. Concentrated animal feeding operations and certain smaller animal feeding operations are considered point sources under the Clean Water Act and subject to NPDES permit requirements.
- ▶ We recognize that our existing regulations for animal feeding operations, which date to the mid 1970s, can be substantially improved in light of current industry practices and the latest scientific information.
- ▶ By this Spring, EPA will take a number of actions to improve the adequacy of controls on the estimated 6,000 CAFOs (i.e., greater than 1,000 animal units) and selected smaller AFOs nationwide. EPA will:
 - finalize its comprehensive strategy for reducing water pollution from animal feeding operations;
 - issue revised guidance to EPA Regions and States that updates existing regulations and clarifies, in cooperation with USDA, expectations for controls to be included in NPDES permits, including the necessary elements of comprehensive manure management plans;
 - commit to a plan for reissuance of NPDES permits, with appropriate nutrient control measures, in the eight States where EPA is the permitting authority, and work closely with the States that have delegated authority, to implement the NPDES permit program to establish commitments for issuing permits, with appropriate nutrient control measures, to all CAFOs;
 - use targeting tools, such as our Index of Watershed Indicators and other mapping techniques, to identify priority watersheds that are particularly stressed by nutrients from CAFOs and smaller AFOs, and issue permits to AFOs in these watersheds as appropriate; and

- finalize and begin implementing a compliance and enforcement strategy to ensure that CAFOs and priority AFOs comply with existing permits.
- ▶ In the longer term (2-4 years), I expect EPA will revise its current NPDES regulations and CAFO effluent guidelines to reflect our improved understanding of the environmental and public health concerns that may be related to nutrients from animal feeding operations. We intend to work closely with the various agricultural commodity groups (including animal feed operators and integrators), USDA, and environmental groups.
- **EPA is also identifying which rivers or estuaries are listed by the States as impaired due to nitrogen and phosphorus or other harmful algal bloom (HAB) indicators (low DO, fecal coliform) and determining whether a Total Maximum Daily Load (TMDL) has been established to adequately reduce the nutrient loadings from all sources.**
 - ▶ It appears that waters identified as experiencing *Pfiesteria* outbreaks to date generally are already listed as impaired for nitrogen and phosphorous. This points to the importance of developing appropriate TMDLs by the States for those waters.
 - ▶ For example, in Maryland, all 10 major watersheds draining to the Chesapeake Bay have been listed as impaired under Section 303(d) for nitrogen and phosphorus. (Some are listed for other impairments as well. For example, the Pocomoke is also listed for sediments and fecal coliform.)
 - ▶ EPA is committed to help every State succeed in fully meeting the requirements of section 303(d) and taking the needed action to implement approved TMDLs. The Agency's policies on TMDL pace and implementation calls for States to develop 8-13 year schedules for developing TMDLs for all waters on section 303(d) lists and for States to

- finalize and begin implementing a compliance and enforcement strategy to ensure that CAFOs and priority AFOs comply with existing permits.
- ▶ In the longer term (2-4 years), I expect EPA will revise its current NPDES regulations and CAFO effluent guidelines to reflect our improved understanding of the environmental and public health concerns that may be related to nutrients from animal feeding operations. We intend to work closely with the various agricultural commodity groups (including animal feed operators and integrators), USDA, and environmental groups.
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 - ▶ It appears that waters identified as experiencing *Pfiesteria* outbreaks to date generally are already listed as impaired for nitrogen and phosphorous. This points to the importance of developing appropriate TMDLs by the States for those waters.
 - ▶ For example, in Maryland, all 10 major watersheds draining to the Chesapeake Bay have been listed as impaired under Section 303(d) for nitrogen and phosphorus. (Some are listed for other impairments as well. For example, the Pocomoke is also listed for sediments and fecal coliform.)
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- We will also help States develop response plans and public education and communication expertise and materials to ensure that the health and safety of their citizens is protected during *Pfiesteria* outbreaks while avoiding undue economic burdens on fishing and tourism industries.

CONCLUSION

Thank you for the opportunity to provide this statement on this important issue. In conclusion, I want to reiterate the Agency's commitment to protecting human health and our nation's coastal and ocean resources from the risks attributable to *Pfiesteria* and other harmful algal blooms. EPA is actively supporting current State efforts and we are moving forward with other federal agencies on a long-term research and prevention plan. We look forward to working with the Committee further on this important issue.

* * *

Henry Werner Meseke Immanuel

2250 Elliott Island Rd
Elliott MD 21869

October 27, 1997

Chairman: Honorable Jim Saxton
Sub-Committee on Fisheries, Conservation, Wildlife, and Oceans
Rm.: H1-805
O'Neill House Office Bldg.
Washington, DC 20515

Kathy Miller: fax: 202-225-1542
Phone: 202-225-2761

Dear Honorable Jim Saxton,

For three years, I have been trying under the Freedom of Information Act (FOIA) to have the Pentagon's Military establishments which have bases, and utilize the Chesapeake Bay and the Potomac River, their tributaries, and wetlands, to release to me records which might reflect what kinds of discharges, releases (accidental or otherwise) detonation or testing of any:

- a) chemical agent or weapon,
- b) biological agent or weapon, and
- c) nuclear or atomic material or weapons.

I also included in my FOIA request a desire to know how these agents have affected the environment (but not limited to contamination), human health, wildlife and their habitats. Needless to say, the Military does not try to have a true open records policy, but rather they are as secretive as can be, which leads me to believe that they are hiding the damage that they have contributed to our health and the environment.

Just months before Pfisteria was discovered in Maryland, I had been trying to receive information pertaining to Bloodsworth Island, of which I had already been made aware that the Island and the surrounding waters (due to deep water discharges) had been contaminated by their numerous bombings that had started in 1942 to the present. This year the Seals desired to utilize the Island for training maneuvers though Bloodsworth Island is ".....completely contaminated with an unknown quantity of unknown types of unexploded ordnance.", (document written in 1988: by the Naval Energy and Environmental Support Activity, Port Hueneme, Ca.; EPA# 7170090016, and this information was compiled in 1981). The facts seem to reflect that the Navy is in denial and does not even acknowledge these reports about pollution. By 1992, the EPA had in their file a Potential Hazardous Waste Site Preliminary Assessment Report (the same id# 7170090016) explaining the problems that existed on the Island. The last document I was to receive was prepared for the U.S. EPA Hazardous Wastes Management Division, by the Dynamac Corporation, Philadelphia Pa., dated: May 18th 93. This too had the same EPA id# 7170090016. The most damaging statement was their summary and conclusion. They claimed that.... "A release to the surface water pathway is suspected because hazardous wastes were directly deposited into wetlands, and surface water is located immediately adjacent to the source. Also, there is no surface water runoff containment. Both primary fisheries and sensitive environments (wetlands) have been identified. Surface water and sediment samples should be obtained from the Bloodsworth Islands to determine whether or not a release has occurred."

These documents were to be public records and open for inspection, though they were nowhere to be found. (EPA: Aug. 18th 1997, "We wish to advise you that the Superfund Program Office has no records responsive to your request.", Larry S. Miller, Chief; PRP Investigation and Site Information Section, addressed to Henry Immanuel). I realized then that something was seriously wrong with their filing system because I did have all of the above mentioned documents in my possession. After going to Congressman Gilchrest's Town meeting at the Pocomoke High School on September 15th 1997 and speaking out about all of the above, things seemed to change. On Oct. 16th 1997, another letter was sent to me by Larry S. Miller in which he now states that ".....the USN Bloodsworth Archipelago (is a) Superfund Site located in Crocherson, Maryland." The big question here is why the long delay in acknowledging this problem? The document was originally filed on March 23rd 1988 in the EPA Region III office. Just how many others documents like this exist in some kind of storage file concerning other Superfund sites in this Country? ! !

These documents are very much a concern of mine because this proves that the government (the Navy and the EPA) had in its possession information which it did not act on. I believe that these documents were suppressed so that the Military Complex could continue there various bombings to the lower Bay with impunity. Needless to say, there are no areas in Maryland and the Bay region that the Military should be able to bomb legally. Simply stated, in such a close proximity to population it can only adversely affect their environment and their health.

I believe that they bought time for themselves so as that they could continue to utilize Bloodsworth Island and its surrounding deep water discharge locations, without regard for human health. A Presidential cease and desist order must be issued immediately to stop the Military from any future bombings to the Bay and its tributaries, so as to protect not only the Bay from further destruction, but to be able to compile data relevant to how our health has been affected.

If we make Bloodsworth Island the central focal point to the Pfiesteria problem on the Eastern Shore, we are then able to see that a short forty miles (40) south is the Pocomoke River area where the Pfiesteria problem was discovered in Maryland; then about forty miles northeast in the upper reaches of Fishing Bay the River known as the Chicamamico is also plagued. The upper waters of Fishing Bay have been utilized by the Navy in the past. The Pfiesteria problem might have a connection to Bloodsworth Island but until an in-depth study of Bloodsworth Island, and the deep water discharge areas are conducted, we will only be guessing at where to point our finger to find blame.

It is easy to blame industry, chickens, and nutrients related to farming. And, though we might clean up these industries for the betterment of society, we truly do not have evidence to prove that they are the culprits. It could even be that Maryland's aerial pesticide spraying for mosquitoes could be having an adverse effect on the Bay!

I also must include these two major bases: 1) the Naval Surface Warfare Center at Dahlgren Va., on the Potomac River; and 2) the Aberdeen Proving Grounds on the upper Chesapeake Bay which are both on the National Priority List with the Environmental Protection Agency. Consequently, they have contributed to the most severe pollution problems within close proximity to a vastly populated area in the United States. This happens to affect every Marylander and Virginian, Pennsylvanian. I have been told by Congressman Wayne Gilchrest (who had responsibility in this sub-committee being organized), that Aberdeen will take fifty(50) years for a complete cleanup, if it is at all possible (in his words), and that is most disturbing.

It would behoove us to immediately look at this problem and consider this a National Emergency Crisis in which the Presidential powers would be instituted to save us from our protectors. In another words, save us from the Pentagon's past mistakes. I only want the Pentagon to be a responsible neighbor, nothing less! But, when we as citizens look at their record of any clean up action on their own volition, it does not seem to be that they are good neighbors. And, when a site is to be cleaned-up it moves forward at a snails pace! We as a Nation need this Crisis to be responded to with the utmost concern. A substantial population is being affected within the States of Maryland, Virginia, and Pennsylvania.

I am hoping that this Congressional Sub-Committee is one for action. The time to act is now on these major pollutants by the Military!! The overriding facts of this problem are that we have no facts!!! We also need to know if their pollution has contributed to the Pfiesteria problem and clean up should be realized as quickly as possible and this means that we are going to have to spend money.

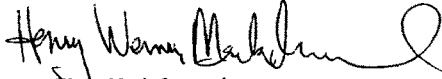
The reason for mentioning these problems with the Military is because no one kept records of the composition and chemical makeup of these long ago dropped bombs. They did not have to legally keep any records till November 5th 1971. We can only guess at what they used in their bombing campaigns and if their pollution has contributed to the Pfiesteria problem.

We should also mention that Dorchester County ranks the highest in the State of Maryland from deaths due to CANCER and that the Eastern Shore of MD leads the country in CANCER deaths overall!!!! It just might be that the problem is the Military!

My recommendation is that the Military must just bite the bombs and work at being a good neighbor. And, on their own stop their bombing campaigns and start their own clean-up action internally with their staff and funds. They must fight this problem as if it is a true war, but without the EPA's expenditures. The Superfund was not made for

them, but for individuals and companies which were either without funds or when no responsible party could be located. Its intention was to be like an insurance company. I have faith that our Military can shoulder their responsibility and take aim at the new target and clean up!!! The Congress, Senate, and the President must be ready to allocate funds as if a National Emergency existed, which it does.

Sincerely,

A handwritten signature in cursive script, appearing to read "Henry W. Meseke Immanuel". The signature is fluid and stylized, with a large loop at the end.

Henry W. Meseke Immanuel

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Donald M. Anderson
 Senior Scientist
 Department of Biology

October 2, 1997

Congressional Testimony: *Pfiesteria* and its Impacts on Fisheries Resources

Subcommittee on Fisheries Conservation, Wildlife, and Oceans
 House Resources Committee
 1134 Longworth House Office Building
 Washington, DC 20515

Mr. Chairman:

I offer the following material to supplement testimony presented to your committee during the October 9th hearing on "*Pfiesteria* and its impacts on fisheries resources". I am a Senior Scientist in the Biology Department of the Woods Hole Oceanographic Institution, and have been active in the study of red tides and harmful algal blooms for over 25 years. I can thus provide the perspective of an experienced researcher familiar with the nature and extent of HAB phenomena both nationally and internationally. I am also Director of the federally funded U.S. National Office on Marine Biotoxins and Harmful Algae, and have been actively involved in formulating the scientific framework and agency partnerships that are needed to attack our HAB problem in an efficient and productive manner.

The recent *Pfiesteria* outbreaks in the Chesapeake Bay have focused scientific and political attention on a specific HAB problem that until recently was struggling for recognition and acceptance. Historically, those working in the field of harmful algal blooms (HABs) have experienced numerous "crises" similar to this one, and the lessons learned about the federal and state response to those problems provide useful guidance to the present. For example, in 1985, a tiny and until then, unknown "brown tide" organism appeared unexpectedly in the waters of Long Island, New Jersey and Rhode Island, causing significant ecosystem and fisheries impacts that have continued to this day. In 1991, a newly discovered algal toxin called domoic acid that can cause severe illness and permanent short-term memory loss in consumers of contaminated shellfish was detected in California, and eventually found in shellfish, fish, and crabs along the coast between northern California and Alaska. Those states continually monitor for domoic acid to this day. In 1987, a red tide swept into North Carolina waters for the first time, causing an estimated \$20 million dollars in damages to the tourist and shellfish industries. Simultaneously, 14 humpback whales died in a one month period in Massachusetts Bay following consumption of fish containing algal toxins.

In these cases and in others, the federal and state response to the highly visible and heavily publicized HAB phenomena was to provide an immediate infusion of funds, personnel, and resources. In the ensuing years, however, that support dwindled and often disappeared as the initial impact of the unexpected outbreaks faded from memory. The algal blooms that are the

source of the above problems have not disappeared, but many of the research teams established to attack them have been disbanded due to the "boom and bust" nature of the funding response.

Recognizing that the scientific community needed to take an active role in changing this inefficient allocation of resources, a workshop was held and a *National Plan for Marine Biotoxins and Harmful Algae* was produced (Anderson et al. 1993). This report documents a scientific consensus on the major impediments to progress and the corresponding recommended actions on all of the major HAB issues that threaten the U.S. The next step was to identify portions of that National Plan that could be attacked by individual agencies or agency partnerships. The first coordinated program element to be addressed in this manner was on the ecology and oceanography of harmful algal blooms. A workshop was held in 1994 and a science agenda prepared to guide agencies in their allocation of resources in that specific area. This agenda was then implemented in the form of the ECOHAB program, a multi-agency partnership led by NOAA (Anonymous 1995). The funding available for ECOHAB is modest, but it is being administered in a scientifically rigorous manner that maximizes research progress, given the diverse nature of our national HAB problem.

The National Plan highlights other areas that need attention, and these priorities are now being refined at workshops and panels so that additional programs and initiatives can be launched. ECOHAB addresses only the ecology and oceanography of HAB outbreaks, whereas the problems and needs span many other disciplines. One potential program being explored at this stage addresses the management, mitigation, and control of HABs (Boesch 1997). Other HAB programs that focus on human health and epidermology are also envisioned.

Research agendas and a scientific consensus on priorities is only part of the process. We thus created an *ad hoc* Inter-Agency Task Force on Marine Biotoxins and Harmful Algae. This group of program managers from a variety of federal agencies concerned with HABs and their impacts meets periodically to review progress on the National Plan, and to form partnerships to facilitate new program implementation. Given the recent *Pfiesteria* outbreaks and the broad interest they have generated among federal agencies, this Task Force could play an active role in advising congress on actions and priorities.

I provide this background to support my view that an excellent framework exists which can be useful in the allocation of resources towards the *Pfiesteria* problem. Earmarked funds or other appropriations that bypass the peer-review process or that do not reflect scientific consensus could well lead to misdirected efforts and inefficiencies.

I should also point out that it is important to place the *Pfiesteria* outbreaks and their threat to human health and fisheries in the national context. It is understandable that those living near Chesapeake Bay are alarmed and concerned by this problem, yet there are numerous other HAB problems that are equally or more serious throughout the country that are presently not receiving attention. In both the northeast and the northwest, for example, thousands of miles of coastline are frequently closed because of the threat of toxic shellfish. Along the coast of the Gulf of Mexico from Texas to Florida, fish kills, toxic shellfish, and airborne toxins are frequent concerns. These are but a few examples - the list of HAB phenomena in this country is long and diverse. The *Pfiesteria* outbreaks have caught the attention of congress and the general public, but it is appropriate for funding to be distributed so as to address all HAB problems, not just the one that is closest to Washington D.C. or that happens to catch the most attention in a given year. Experience tells us that next year or the year after, this problem will likely have diminished greatly while another manifestation of HAB phenomena will appear dramatically elsewhere.

I cannot emphasize too strongly the need for sustained and broadly based research funding. It is the only way to keep research teams intact, forming the core of expertise and knowledge that builds on itself through the years and leads to solid research productivity. It would be highly inefficient and reminiscent of the "old" days before we organized our national HAB activities if funding were to ebb and flow in synchrony with the episodic red tides and harmful algal blooms.

Respectfully submitted,



Donald M. Anderson
Senior Scientist

Literature citations:

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STATEMENT FOR THE RECORD
BY
DR. MARK SCHAEFER
DEPUTY ASSISTANT SECRETARY FOR WATER & SCIENCE
AND ACTING DIRECTOR, U.S. GEOLOGICAL SURVEY
DEPARTMENT OF THE INTERIOR
BEFORE
THE COMMITTEE ON RESOURCES
SUBCOMMITTEE ON FISHERIES CONSERVATION, WILDLIFE, AND OCEANS
PFIESTERIA AND ITS IMPACTS ON OUR FISHERY RESOURCES

October 9, 1997

Mr Chairman, I appreciate the opportunity to provide this statement for the record on *Pfiesteria* and its effects on fishery resources. I would like to describe the role that the U.S. Geological Survey (USGS) has and can continue to play in assisting the states as they address this issue. With the integration of the Department's substantial and longstanding biological research capabilities into USGS last year, the Bureau can provide a wide range of integrated scientific information to aid in determining cause and effect relations, help predict responses of the ecosystem to future stresses, and contribute to the development of strategies to mitigate *Pfiesteria* and other toxic blooms.

The USGS has about 10,000 employees that work within four major scientific divisions: Water Resources, Mapping, Geologic, and Biological Resources. The organization focuses on multidisciplinary approaches to problem solving while providing the Nation with reliable, impartial information to describe and understand the earth. The USGS has been actively involved in Chesapeake Bay studies since 1983. In 1996, the Chesapeake became a USGS ecosystem program area, an integrated multidisciplinary effort to understand human and natural influences on the Bay environment.

The toxic blooms that are believed to be due to *Pfiesteria* in Chesapeake Bay are a serious public health and environmental concern. While water quality has generally been improving over the past decade, this recent outbreak is an indicator of ongoing problems with water quality that may be occurring throughout the Bay and its tributaries. While it is not yet proven whether the

Pfiesteria outbreaks in the Bay were directly caused by nutrient concentrations in the Bay, a growing body of evidence correlates a number of toxic blooms throughout the U.S. with elevated nutrient concentrations in water.

The *Pfiesteria* outbreak in the Bay is not an isolated incident. Several years ago the Albemarle-Pamlico estuarine system in North Carolina was the site of a major fish kill; this summer the problem occurred in Chesapeake Bay. There have been a number of recent harmful algal blooms other than *Pfiesteria* that continue to occur throughout Atlantic and Gulf Coast ecosystems. In recent years, fish kills have become more common throughout the entire coastal region of the United States.

Water quality concerns linked to nutrient concentrations extend even beyond direct fish kills caused by toxic blooms in the coastal zone. Currently the Gulf of Mexico is plagued by the largest zone of hypoxia ever reported in the western Atlantic and Gulf region. The zone covers about 7,000 square miles. The waters in this zone have insufficient oxygen concentrations to maintain healthy fish and shellfish populations. A suspected cause of the hypoxia is nutrient enrichment from the waters of the Mississippi River basin.

Toxic blooms impact not only fisheries, but also other parts of the marine ecosystem. For example, in 1996, a red tide off the coast of Florida was responsible for the deaths of some 150 West Indian manatees, an endangered species.

There are numerous consequences of *Pfiesteria* and related outbreaks of harmful blooms: the threat to human health; a decrease in fishery biomass which reduces the catch of commercial and sport fish; the economic loss due to the perception of contaminated seafood products and a reduction in sport fishing activity in the area; and the loss of recreational and aesthetic value associated with closed rivers.

Finding a cause for these events is a high priority so that land and water area management changes can be instituted. Determining the causes and effects of these toxic blooms requires scientifically credible information on: 1) the ecology of toxic blooms, how they affect fish and impact other marine and estuarine biota, and how blooms respond to different environmental conditions; 2) how the conditions that precipitate blooms develop; and 3) how can they be mitigated.

Beyond a broad understanding of the ecology of the *Pfiesteria* and the organisms it affects, it is important to understand the direct cause of the fish kills. USGS scientists have found a variety of lesions on fish, with evidence of bacterial, fungal, and protozoan infections. Without the presence of a characteristic lesion that can be identified specifically as a response to *Pfiesteria* toxin, it is premature to conclude that all the fish mortality is *Pfiesteria* induced. While some lesions may be secondary infections following exposure to toxins, there is evidence that some are not. USGS fish-related studies are focussing on the possibility that fish in the Bay may have suppressed immune systems enabling a host of opportunistic pathogens, particularly fungi, to cause disease and impact fishery resources.

Determining the risk that toxic blooms pose to the entire aquatic community is also very important. USGS scientists were instrumental in identifying red tide as a causative factor in the deaths of Florida manatees in 1996. Our world-class labs and technical specialists routinely provide support to Federal, State, and local managers as well as initiating their own investigations of fish and wildlife mass mortality events. There is a need, however, for improved technology in diagnostic assays that can confirm the presence and type of toxins from blooms that are found in fish and wildlife.

Nutrient enrichment of surface waters is suspected of contributing to *Pfiesteria* and other toxic blooms. The organisms responsible for these blooms in coastal waters are highly varied and the ways that they respond to conditions found in coastal waters is uncertain. Several different species of *Pfiesteria* in any number of life forms may be present. It has been shown in

laboratory studies that *Pfiesteria* responds positively to increases in nutrients but reacts differently to phosphorus than it does to nitrogen. The variable response of *Pfiesteria* to nitrogen and phosphorus coupled with the fact that these two nutrients may have different pathways to Bay waters, underscores the importance of research on nutrient transport and fate. In most coastal plain watersheds, ground water is the primary pathway for water delivery and nutrient loading. The USGS has shown that 50 to 80 percent of streamflow and up to 60 percent of the nutrient loads to coastal watersheds are from ground water. The quantity and quality of ground water varies both locally and regionally based on natural differences in soils, geomorphology, and geologic structure of different subsurface environments. Current and historic land use and land practices also affect ground-water quantity and quality. An understanding of these different subsurface settings and their relations to land use, flow, and biogeochemistry is critical in predicting *Pfiesteria* and other toxic blooms and in developing meaningful strategies to prevent or mitigate future outbreaks.

Understanding the causes and effects of toxic blooms requires a multidisciplinary and multiorganizational approach. Knowledge of the biology of organisms responsible for these blooms and the hydrologic and geomorphologic processes that control runoff and subsequent water quality will be needed to determine if changes in land use practices have the expected impact on conditions in the estuaries. Monitoring of the movement of nutrients via streams and ground water into Chesapeake Bay and major east coast estuaries is critical to understanding this problem. Except for USGS monitoring of the largest rivers, this kind of monitoring is virtually nonexistent. Such additional monitoring, which could be undertaken by USGS staff, would provide information on long-term trends in nutrient loading and also define the impact of individual storm events. In addition, EPA's EMAP program has developed approaches to periodically characterizing the ecological condition of coastal and estuarine areas, and this should be integrated with the USGS work. Additional new biological monitoring activities through extended fish health surveys conducted by USGS and the Fish and Wildlife Service, and measurements of the effectiveness of riparian buffers would provide a means to evaluate management actions, as well as an early warning for other potential problems.

The USGS also has the capability to reconstruct environmental conditions in the Chesapeake Bay during the past 100 years by collecting and analyzing sediment cores. Such information is of importance in providing the proper context for understanding and investigating current conditions. Additional insights could also be provided by measuring and modeling the movement of fine-grain sediments and mapping sediment deposition and composition as key data in efforts to predict optimum conditions for the occurrence of harmful blooms.

One of the most effective ways to make large quantities and various kinds of data available to policy makers is through Geographic Information Systems. High resolution data and advanced visualization techniques, coupled with predictive models can aid in evaluating alternative policy scenarios. By integrating data layers on nutrient delivery, sediment information, land use patterns, and fish and wildlife health, high quality decision support systems can be constructed for use by researchers and resource management officials.

The real strength of the new USGS with respect to *Pfiesteria* and other harmful blooms is our internal ability to integrate information needed to determine causality. Basic ecological information, and an understanding of interaction between fish and *Pfiesteria* must be complimented by information on water quality, historic records of past events and responses, and physical factors that control water quality. This allows us to describe cause and effect relationships, develop predictive capabilities, and evaluate the potential impact of changes in land use practices.

We are committed to working cooperatively with the States, other federal agencies, universities, and other research organizations to help address this important problem.

Again, I appreciate the opportunity to submit this statement for the record. I would be pleased to supply additional information or respond to any questions.

TESTIMONY OF JAMIE RAPPAPORT CLARK, DIRECTOR, UNITED STATES FISH AND WILDLIFE SERVICE, DEPARTMENT OF THE INTERIOR, BEFORE THE SUBCOMMITTEE ON FISHERIES CONSERVATION, WILDLIFE AND OCEANS OF THE HOUSE RESOURCES COMMITTEE, REGARDING PFIESTERIA AND ITS IMPACTS ON OUR FISHERY RESOURCES.

October 9, 1997

Mr. Chairman, I greatly appreciate the opportunity to enter into the record our comments and concerns regarding *Pfiesteria* and its impacts on fishery resources. Several Federal agencies are providing assistance to the affected States in a number of areas, as the understanding of and response to the environmental health problems related to this toxic dinoflagellate requires a multi-disciplinary, coordinated response.

The U.S. Fish and Wildlife Service has a long record of involvement and achievement in Chesapeake Bay restoration, and is working with other federal and state agencies to find solutions to this serious problem. To the maximum extent possible, the Service will apply its resources where they can provide the most help. Presently, the Service's Chesapeake Bay Field Office is assisting the State of Maryland in the immediate crisis by helping with fish sample collections, and providing a representative on the Federal Interagency Task Force that has been created to provide overall support to the State.

The Service's Fish Health program is currently conducting a National Wild Fish Health Survey that has responded to the crisis by targeting sites selected by the State for sampling. The Survey is designed to identify the geographic distribution of any dangerous pathogens that may be present in wild fish. This information will provide a health profile that can either identify other

causative agents responsible for producing lesions and/or disease, or provide information on other conditions that may render the fish in the Bay susceptible to *Pfiesteria* or other potentially dangerous pathogens.

Besides the direct effects on fishery resources in the Chesapeake Bay, the Service is concerned about the effects of *Pfiesteria* or other toxic algae on Department of the Interior trust wildlife species along the Atlantic coast. The Department has a series of National Wildlife Refuges and National Parks along the east coast, all providing habitat for migratory and resident wildlife. Many of these Interior lands support estuarine systems vulnerable to over-enrichment and resultant risk of toxic blooms.

While there is no specific evidence of impacts to trust wildlife resources, fish-eating birds may be vulnerable to problems resulting from eating toxin-laden fish. Common loons (a species of management concern), eagles, osprey, brown pelicans, herons and egrets, waterfowl, and terns (including several species that are endangered or threatened) are among the many species that may be exposed along the Atlantic coast. Identifying areas of potential risk and sites for continual monitoring of affected wildlife will be important aspects of our on-going efforts to conserve and enhance the populations of these species.

The Service recognizes that *Pfiesteria* and its possible association with nutrient enrichment represents a larger, more troubling issue - that of non-point source pollution. The goal of the Clean Water Act (Act) is to restore and maintain the chemical, physical, and biological integrity

of the Nation's water resources. The Act, by all accounts, has dramatically improved the water quality of America's lakes, rivers, and estuaries. However, although the Act has effectively reduced pollution from point sources, its impact on other pervasive causes of chemical, physical, and biological degradation has been less profound. Nonpoint source pollution, especially runoff from agricultural and urban areas, is now the most significant cause of water quality problems. Although regulation and mitigation measures have reduced these inputs, in some cases our waterways are not yet "fishable and swimmable", as had been hoped for with enactment of that legislation.

The Service is seeking opportunities to work with agencies, states, and local groups to address nonpoint source pollution by applying comprehensive watershed approaches. The health of the Nation's waterways is intimately related to watershed health. Watershed management reflects a realization that, in addition to government agencies, local, non-government watershed groups can develop and direct water quality improvement initiatives. Good coordination between these local groups and the appropriate State and Federal agencies will benefit all parties, including the affected fish and wildlife resources.

The Service will continue to work with our partners to address these concerns and help provide solutions to the *Pfiesteria* crisis as well as other fish health issues that can be averted by a watershed approach to environmental pollution. For example, the Service's North American Wetlands Conservation Act grant program has protected and/or restored thousands of acres of riparian wetlands. These wetlands filter nonpoint source runoff and decrease pollutant loadings.

The Partners for Wildlife Program develops cooperative agreements with private landowners that result in soil conservation, the provision of wildlife habitat, and the improvement of water quality. National wildlife refuges, many of which are adjacent to bodies of water, also can reduce pollution loadings from nonpoint source runoff. These programs represent a few examples of existing programs that enhance water resources and their dependent biota. Many of these programs are examples of the trend toward partnerships in habitat maintenance and restoration that are the foundation of watershed management.

The Service also cooperates with the Department of Agriculture (USDA) in several programs providing major benefits to fish and wildlife. These programs include a recently formed partnership with the USDA and Maryland that will expand the USDA's Conservation Reserve program. Up to 100,000 acres of environmentally-sensitive lands along Maryland streams and rivers will be set aside and maintained to protect water quality.

The Service can also assume a partnership role in the planning, implementation, and evaluation of watershed programs to improve the chemical, physical, and biological integrity of water resources. Incorporating both existing programs and new initiatives, the Service can promote non-regulatory, locally-driven efforts to conserve fish and wildlife and help control diffuse sources of water quality degradation.

I thank you, Mr. Chairman, for the opportunity to submit our remarks before the subcommittee, and look forward to working with you to address this important environmental health issue.